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GRAZING CAPACITY STUDIES OF CATTLE

By

Elwood Williams Stringam

Department of Animal Husbandry

University of Alberta,

April, 1942.

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GRAZING CAPACITY STUDIES OF CATTLE.

By Elwood Williams Stringam

A THESIS

submitted to the Department of Animal Husbandry of the University of Alberta in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE.

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Thesis
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PREFACE.

I wish to thank Professor J. P. Sackville, Head of the Department of Animal Husbandry, University of Alberta, for affording me the facilities of his Department. The sincere cooperation of Mr. H. J. Hargrave, Superintendent of the Dominion Range Experiment Station at Manyberries, in allowing me access to the Station files and his many helpful suggestions in the preparation of the reports are gratefully acknowledged. I am particularly indebted to Dr. R. D. Sinclair, Dean of Agriculture, University of Alberta, for the invaluable and appreciated suggestions and criticism offered in the preparation of this manuscript.

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GRAZING CAPACITY STUDIES OF CATTLE

INTRODUCTION.

The short grass Prairie area of Alberta has always played an important part in the range livestock industry of western Canada. Although Alberta did not see the influx of the cattle ranchers into this and other areas until the middle 1870's, by the turn of the century many large cattle companies had stocked thousands of acres of the virgin prairie with the finest type of range beef cattle. Range was practically unlimited.

Though the years since have seen many changes in the cattle industry, in this area lying east of a line drawn from a point on the international boundary south of Cardston to Drumheller, and south of a line from Drumheller east to the 4th meridian, ranching is still an integral part of Western agriculture. Within its forty million acres are still to be found large areas of native pasture and abandoned lands supporting a total of some 300,000 head of cattle and 280,000 head of sheep. (1)

The days of unlimited range, however, have passed into history. The rancher has been forced by the incoming settlers to diminish his holdings, but harassed by the starvation prices of the post war depression has been compelled to keep up the numbers of his livestock in order to pay expenses and exact a living. In the subsequent drought

years, when his over stocked pastures have been swept by the dry chinook winds, the rancher has been brought to face a serious problem, that of the preservation of his coveted range.

To solve this and other range problems, a Range Experiment Station was established in 1927 by the Dominion Government on an area southeast of Manyberries, Alberta. Several experiments were inaugurated in the years following the establishment of this station. Among the investigations undertaken was one designed to determine the effect on the grass cover of pasturing systems that entailed grazing cattle at different acreages per head continuously or under a plan of deferred and rotational grazing, and to study the effects of these systems on beef cattle production. This experiment was started on definite lines in 1931 and was termed the Carrying Capacity Project.

It is the purpose of this thesis to discuss this experiment and the results obtained insofar as they are related to the growth and reproduction of the livestock used.

The problems to be dealt with may be briefly stated as follows:

1. The effect on the growth and thrift of range cattle when they are grazed at different acreages per head.
2. The percentages and quality of the calf crop from these range cattle.

The significance of this study lies in the fact that

the system of grazing selected as the optimum must be one that will permit normal growth and reproduction of range livestock as well as facilitate the complete utilization and preservation of our most common resource - grass. When this system of grazing has been established, it will serve as an index to the proper management of our range industry.

REVIEW OF LITERATURE

Measurements of Growth

Before the experimenter can ascertain the differences in growth of groups of animals on different planes of nutrition, some system of weights or measurements or both must be selected to express these differences. Generally, each type of growth (fattening or skeletal growth) may be indicated by specific body measurements. Some measurements may, however, be indicators of both skeletal and fattening growth.

Trowbridge, Moulton and Haigh (2) in their studies on the energy cost of fattening beef cattle suggested that height at withers, length of body (shoulder to the hip bone), and the width of the hips were chiefly measures of skeletal growth. The latter measurement, in that it suggested the width of the animal, was also an indication of fleshing. They reported in later studies (3) that this measurement could almost invariably be correlated with the plane of nutrition on which the animal was maintained.

Lush and his co-workers (4) seem to agree with these findings. As a result of their work with Brahman and Hereford and Brahman-Hereford Cross range cattle, they also concluded that chest width, loin width, width at pin bones, and hear girth were principally measures of fatness.

In making measurements, one must keep in mind that certain parts of the body grow faster than others. One must also remember that there is a difference between species as well as between the sexes in the development of different sections of the skeleton. Lush and his associates also demonstrated this in their work (4). Quarter blood Brahmans are slightly heavier than Herefords of the corresponding age on the same range. Heifers of both species grow more slowly than the steers of the corresponding species. If weight then is to be accepted as the sole measurement of growth in comparing groups of cattle, the allotment of experimental groups must be on a basis of mature animals of the same sex and species.

The stock man is, of course, interested in the ultimate number of pounds of good beef produced from his animal regardless of its plane of nutrition. Does any relationship exist, therefore, between the body measurements mentioned in the foregoing paragraphs as measures of the planes of nutrition and those denoting dressing percentage? Lush (5) noted that the most significant measurements in relation to high dressing percentage and meat value were a large

heart girth, in connection with a shallow chest, a wide loin, a small paunch girth, head narrow at eyes, and a lack of height over the hips. These qualities were not, however, those that could be associated with maximum gains. In fact, to the alert animal husbandman, many would serve as measures of disqualification in selecting breeding stock.

Growth and Planes of Nutrition

Growth and planes of nutrition studies have most generally, in the past, been made on animals under dry feeding or paddock conditions. They present a general picture of the physiological processes in the animal body, the basic principles of which will generally apply to cattle under range conditions.

Moulton (3) studied the changes in form and weight of feeder steers on three planes of nutrition (high, low, and maintenance). Although the scantily fed cattle grew less rapidly, they reached the same height over the withers at maturity. Length, width, and circumference of the body were, however, materially decreased by the poorer rations as was weight. This would mean, according to other reports of these workers, that on lower planes of nutrition measurements denoting fleshing were the first affected by the scanty feed. This seems quite reasonable.

If the animals will produce the same body development under a scanty ration, would it not then be to the best advantage of the stockman to stock his range heavily, and

produce either the lightly fleshed animals that would have a high dressing percentage, or just to produce the skeleton and let the "feeders" finish them? With regard to the first suggestion Moulton and co-workers (17) stated that the ratio of empty weight to live weight was greatest at birth, least at 8½ months, and intermediate at four years. A lower plane of nutrition gave lower ratios. The latter could, in part, be due to the marked retardation noted in the development of the stomachs and livers of the animals in this same group. Other conclusions made by these workers were that generally in the carcasses the proportions of the more expensive cuts as loin and rump increase with age and better planes of nutrition. Round was the only expensive cut that decreased. The cheaper cuts, as flank and plate, increased, but those of the chuck and neck, shin and shank, decreased with age and the higher planes of nutrition. Rib cuts were affected very little. The distribution of total lean flesh was affected very little by increasing age and higher planes of nutrition except for a slight reduction in the proportion found in the shin, shank, head, and tail and occasionally in the round. The distribution of the total skeleton is affected but slightly by age and the plane of nutrition.

As to the second suggestion, Ritzman and Benedict (6) in studying the ability of the animal to regain flesh lost, concluded that not only did the animal fail to make immediate

gains when removed from the light to a heavy ration, but also the economy of such a practice forbade its use. Further, they pointed out that there was a difference in physiological processes of the two groups which, in some cases, could prove a serious detriment to the health of the animals on the subnormal ration.

There was no difference in body temperature of the two groups of animals. Pulse rates of the sub-maintenance group fell during their period of scanty feed and rose above normal when they were later placed on the heavy diet. Particularly noticeable was the gradual slackening of the sebaceous secretions in the sub-maintenance group, causing the skin and hair tone to become harsh and dry. Salivary secretions, however, continued for a time after this group was placed on sub-maintenance rations. When they were placed on fattening rations at a later period, they did not seem as overly greedy for food as they might have been expected to be.

The significant finding in this study to the stockman was the economy found in finishing the steers. It was definitely in favor of the maintenance group indicating cattle should receive adequate feed supplies throughout their growing period.

Brody (7), drawing his conclusions from studying small animals as the Norway White Rat, and from studies with dairy cattle, suggested that the best economy was to supply

sufficient feed to grow animals as quickly as possible. He also suggests, that chronological age not being identical with physiological age, weight and not age should be the determining factor in breeding young cattle.

Growth and Nutrition of Cattle on the Range

Most grazing studies have been conducted primarily from an agronomic point of view. That is, with the desire to find the effect of overgrazing on the range resources. The actual performance of the cattle, though important, has seldom been studied in detail.

Neale (8) stated that if the maintenance requirement of an animal is proportional to its body weight under feed lot conditions as has been pointed out by other workers (9), this hypothesis could easily apply to cattle on the range. The weight of the mature cow and her calf seemed to serve, he stated, as the indication of the plane of nutrition on which they had been raised. Their variation from the ideal is usually a measure of over or under stocking, keeping in mind, of course, mineral deficiencies on the range.

In small paddock studies Hulme (10), using purebred Shorthorn cows and calves as subjects, experienced 7 per cent greater gains in the cattle on rotation pastures after two years. In its fifth year the gains of these cattle were 30 per cent greater. The effect on the pasture density was also in favor of the rotational practice.

Sarvis (11) reported on a group of interesting experiments

on Grazing Capacities in 1923. Five pastures were used under the scheme; 100 acre, 70 acre, 50 acre, 30 acre continuous, and 70 acre rotational respectively. These were grazed during the season from May 15 or June 1 to October 15 or 30 by comparable lots of cattle (10 head each). The 70 acre rotational pasture was divided into three pastures grazed at three different periods of the year in such a way that no pasture was grazed at the same part of the season in any three consecutive years. Individual weights of the steers were taken periodically. From these, some interesting data is forthcoming.

The 100 acre pasture showed undergrazing and the steers in this and the 70 acre pasture showed the highest gains, there being little difference between the two. These had gross forage carryovers of 49 per cent and 26 per cent respectively. The 30 acre pasture was overgrazed and the cattle began to fail to make normal gains as early as July. The 50 acre pasture could not carry the cattle through past September. The rotation pasture produced higher average gains per acre than the 50 acre continuous pasture and a 21 per cent carryover of grass. The conclusions drawn from this experiment were:

1. Ample pasturage is necessary if a high individual gain is desired.
2. High gains per acre are associated with low total gain per animal.

Too early spring grazing, continuous grazing associated with overgrazing were factors regarded as the prime causes of pasture deterioration.

Black and associates (12) used three pastures in a similar study. These were 150 acre, 80 acre, and 160 acre respectively. The latter pasture was divided into two fields and each grazed half the year, the same portion being grazed during the same season for two consecutive years.

The most interesting conclusion made in this study is that where pastures of the same size are not pastured by equal numbers of cattle, gain per acre is not a fair estimation of the value of the forage present as two year old steers will require one-third to one-half of the feed they consume for maintenance. Other conclusions made by these workers were:

1. The rate of stocking of range land should depend primarily on which market it was desired to produce the beef for, suggesting that ranges might be more heavily stocked if feeder cattle were to be produced than they could if grass finished cattle were desired.
2. Supplemental feeds (barley) only paid for the enhanced gains that it produced on the range in one out of three years, though it produced better gains each year than were obtained on the same pastures when it was not fed.

Vas and Lang (13) have advanced from the pasture field

type of study in that they have established a forage index by which they can calculate the grass cover. Then by using a palatability table, they can estimate the actual feeding value of the forage present in the range. Using these tables, they estimate the carrying capacity of the Red Desert area of Wyoming to be 131.75 surface acres per cow.

The results obtained by Camp (14) in his study of the Alachia County range of Florida, attributed the differences in the carrying capacity of the range and its consequent effects on the livestock to the types of vegetation. Poor gains, he stated, were experienced on wire grass range during the latter part of the season, likely due to the nature of the grass at maturity. The difference in the nutritional value of the various types of vegetation was responsible for the success or failure of the different ranches according to their location.

A probably worthwhile suggestion on range conservation and increased gains in the range livestock comes from Stoddart and co-workers (15) in their study of range conditions in the Uinta Basin of Utah. They suggested that in the rehabilitation of the range in that area some combination of these four adjustments might be made.

1. More supplementary feeding on the range.
2. Increased farm feeding.
3. Some shifts in seasonal use of the range.
4. Reduction in the numbers of stock grazed on spring, fall, or winter ranges.

They have made their studies particularly from the agronomists' point of view and show no weights of cattle to substantiate their claims.

In a similar study (16) conducted by Stoddart in Rich County, similar conclusions were drawn with respect to the range livestock industry.

Phosphorus and Calcium Deficiencies in the Nutrition of Range Cattle

It has long been known that much of the forage on cattle ranges in different parts of the world was deficient in minerals essential to the normal growth and reproduction of livestock. Principal among these are calcium and phosphorus.

Theiler and associates (31) working with cattle on South African ranges concluded that the feeding of bone meal and other supplements rich in phosphorus materially increased the size of the calf crop.

Schmidt (28) reported in 1926 that the feeding of bone meal to range cattle as a supplement to the phosphorus deficient pastures of the coastal plains of Texas resulted in the cows making increased gains, raising better calves, and prevented a condition known as "creeps". This condition is apparently associated with osteomalacia.

Knox and associates (25), studying the phosphorus intake of cattle on the ranges of Southern New Mexico, concluded that the phosphorus content of the forage in that area was insufficient to permit normal growth and reproduction of these animals. They found that the feeding of supplements rich in phosphorus corrected this deficiency. They also

concluded that no serious deficiency existed in the calcium content of the forage.

These workers cited the studies of Watkins (30) in which this experimenter concluded that the phosphorus content of the grass in 11 of the 31 counties of New Mexico was below the minimum level of between .11 per cent and .12 per cent believed necessary for normal growth and reproduction of range cattle (25). Watkins, in this study, stated that the calcium content of the forage was only less than the .23 per cent required by range cattle in 3 out of the 31 counties.

They also cited the work of Stanley and Hodgson on the range forage of Arizona. These workers reported the grasses sampled on the range of southern Arizona contained .18 per cent to .40 per cent phosphorus in the growing season and but .044 to .065 per cent in mid-winter.

It is obvious that these possible mineral deficiencies must be taken into consideration in discussing the growth and reproduction of range cattle in southern Alberta.

Having briefly discussed the planes of nutrition of range animals and their significance to the rancher, some phases of the experiment on "Carrying Capacities" conducted at the Dominion Range Experiment Station at Manyberries and upon which this thesis is based will now be discussed.

CARRYING CAPACITY PROJECT

In 1931 a joint project was begun at the station under supervision of both the Animal Husbandry and the Forage Crops divisions to determine the actual carrying capacity when pastures are grazed continuously and when they are grazed under a deferred and rotational system at varying acreages per head.

This project was carried out, except for the change of cattle in 1932, as originally intended until the spring of 1938. At this time, the deferred and rotational sections of the scheme were discarded. The other lots were carried on until the spring of 1939 at which time the cattle were replaced with yearling heifers. This project is still being continued at the station as confirmation of the results already obtained and to further determine the effects of different grazing intensities on the grass cover.

It is the specific purpose of this thesis to discuss the performance of the cattle used in this project from the spring of 1932 until the spring of 1938. Since it is desired to subject the data gathered to statistical analysis and to make this analysis such as to extend over the period of six years, only data obtained on those animals still in use in the spring of 1938 will be used. Animals were discarded generally as the outcome of two factors, either failure to get with calf or death.

EXPERIMENTAL PROCEDURE

Selection of the Pastures

In order to give some idea of the range chosen for the pasture, the following few paragraphs from the "History of the Lease" are quoted. This history was written in the fall of 1927 and is on file at the Station office.

"It is interesting to note the report made by the Topographical Survey in 1908. It is as follows:

'This township is reached by a good trail from Medicine Hat, the nearest railway station, about ninety miles north. The soil is a gravelly loam and gumbo, which grows good range grass, but is too hard and dry for agriculture. The surface is gently rolling prairie, and is destitute of timber of any description. Hay during wet years, no doubt, is to be had, but anything in the shape of meadow is at present dried up. Water was only had this year in a spring at the southwest corner of the township; all creeks were dry and there were no water holes. The climate is exceedingly dry, with hot winds throughout the months of July, August, and September, and there were no indications of frosts during those months. Fuel, in the shape of spruce timber, is to be had at Eagle Hills, about twenty-five miles to the northwest; no indication of coal or lignite was seen, nor any stone or minerals. Game, in the shape of antelope, was fairly plentiful, but no other kind were seen.'

"In conversation with ranchers who have been in this country for the past 30 years, they state that when they first came to the country there was a level bed of grass all over the range. The range land was open, and it was not until 1912 that the closed lease system was adopted. This particular area of southeastern Alberta and southwestern Saskatchewan has always been considered a good ranching area, due to the favorable winters and the nutritive value of the grass. When the closed lease system was put into operation, the ranchers believed that the supply of grass was unlimited. However, years of continuous grazing on defined areas soon had its effect and in 1926 the condition of the range was so bad that many ranchers had to decrease their herds, while others have had to go out of the business entirely. 1927 has been an exceptionally favorable year, and today is found a growth of grass that many ranchers state has never been equalled in the history of the country."

Nine fields were constructed south of the station buildings in such a manner that stock in any of them would have access to water. A diagram of the fields is shown in Plate I.

It was proposed to test the following carry capacities: 20, 30, and 40 acres per head under a continuous grazing plan necessitating fields of 200, 300, and 400 acres respectively. Under the deferred and rotational grazing plan, it was proposed to test only the first two rates (20 and 30 acres respectively) as information would be gathered from the large fields at the station on the latter.

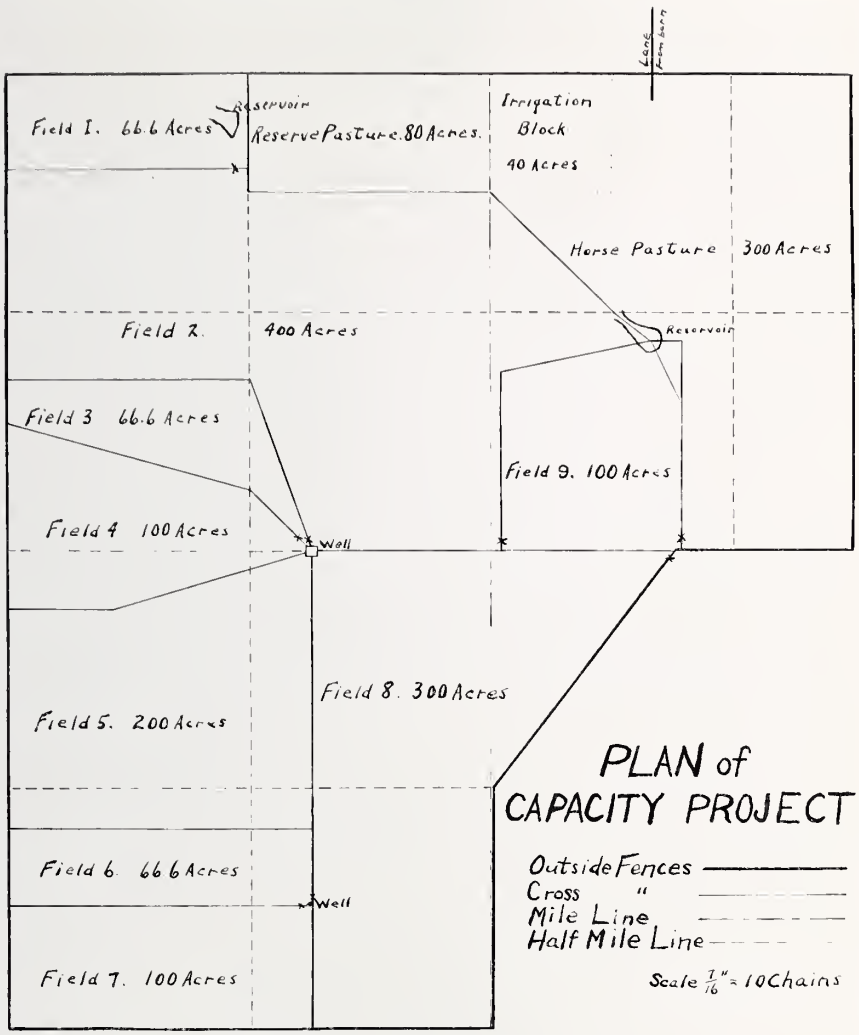

Plate I - Showing arrangement of fields.

These two rates would require three fields each. One group, of which each was 66 2/3 acres in area, and another group of which each was to be 100 acres in area. The proposed system of rotation of these fields is shown in Table II, Appendix III.

Selection of Cattle

In the spring of 1931, 50 head of yearling Hereford heifers were chosen from the Gilchrist range herd. These were an average group and were divided into lots of ten, being branded to denote their lot and with individual numbers 10 to 59 inclusive. Each lot of 10 was as uniform in type, quality, and condition as it was possible to get them. In 1932, this group was discarded due to the differences that were apparent in their development and also due to the fact no provisions could be made to have them bred that summer. Another group was selected at this time and most of these were still in use at the end of the experiment. These were also divided in 5 lots of 10 head each, Lot 1 to be grazed under the rotational plan at 20 acres per head, Lot 2 at 40 acres per head under the continuous plan, Lot 3 at 30 acres per head under the rotational plan, and Lots 4 and 5 at 30 and 20 acres per head respectively under the continuous plan.

During the period of years over which the experiment extended, it became necessary to make occasional replacements in the different lots due to deaths of some of the

original cows or to their failure to breed. Weights of these replacements were taken while they were on pasture just as a matter of interest, but no permanent record kept as the same cows were not used each year as replacements. Where possible, these were of an age and class comparable to those they were replacing. If such were not available as replacements, mature two year old heifers were used. Replacements were always taken from the range herd of Gilchrist Brothers.

Summer Feeding and Management

All lots were turned into the summer pasture (capacity fields) as soon as the grass was considered to be well started in the spring, between April 14 and April 20, usually around April 15. Supplementary feeds were only fed on one occasion after the cattle were turned into the pasture. This was to prevent deaths after a hard winter and a cold spring. Salt and water were available to the animals of each lot at all times. No artificial shelters of any description were provided.

Two purebred bulls were used during the breeding season to breed the cows in the five lots, these being moved from pasture to pasture as they were needed.

Calving commenced shortly after the cows were turned out to pasture. The calves were branded and vaccinated, and the males castrated, according to the usual range practice. They were also marked to designate their maternal parentage. After the final weights were taken in the fall,

the calves were weaned and no further record was kept of them.

Winter Feeding and Management

The cows were taken from the summer pasture in the fall and placed on the winter range at the time cattle would usually be moved from the summer range between October 15 and November 20. Usually this was around the first of November. No shelter except that provided by the natural topography of the pasture was available. Supplemental feeds were only provided when it was absolutely necessary. The extent of this varied from year to year, mainly due to the changing climatic conditions. Shelter was often provided in these cases. The usual ranch practice of segregating and feeding only those individuals needing feed was the system followed.

Salt and water were available at all times to the animals.

Weights

Individual weights of the cows were obtained at the beginning and end of the summer grazing season, the weight recorded being the average of weights taken on three consecutive days and credited to the central day. Other weights were recorded at regular intervals throughout the summer and winter grazing seasons. The calves were also weighed individually at this time during the summer season. The system followed is shown in Table I, Appendix III.

Different body measurements were made on the animals

in the early stages of the experiment as a means of studying their body development. Due to the inaccuracy experienced in making these measurements, this phase of the experiment was discarded after 1935.

Forage Crop Reports

The Forage Crops Division established a system of quadrats and other botanical studies to study the influence of the different systems and intensities of grazing on the vegetative cover. Brief reports were made on these studies each year mainly in the form of estimated forage carry-overs.

OBSERVATIONS AND RESULTS

This experiment will be reported in yearly sections constituted by the summer grazing season and the following winter season. This method is followed as it is the logical way to study the effects of the summer grazing on the various lots of cattle.

As was stated previously, only the animals still being used in the experiment in the spring of 1938 will be considered in the statistical analysis and in the report where reference is made to this analysis or to tables.

Each year, however, if losses from the original 10 head per lot occur, these will be mentioned together with the cause of such loss. The number of original animals per lot completing the experiment were for lots 1 to 5 in-

clusive, 6, 8, 8, 8, and 6 head respectively.

Grazing Period No. 1 - 1932-33

Seasonal Notes

This year was marked with a heavier than usual summer rainfall following a year in which the summer was quite dry. Some 13.13 inches of moisture fell during the season January 1 to December 1, 1932, considerably more than the previous five year average. Over half of this fell during the months of April, May, June, and July.

The winter of 1932-33 was mild, as was the previous winter with the exception of a week of severe weather early in February. Heavy snow fell in November. This was blown into drifts by a high wind a few days later leaving the ridges bare. A chinook followed, melting much of the snow. Little moisture fell during the rest of the winter. Chinook winds were common.

Progress Report

All lots made steady gains from April 9 to November 8 as is shown on the graph, Plate II, the heaviest daily gains being made in the period April 9 to June 26. During the period November 8 to December 13 decided shrinks were observed in all lots. This was probably due to the heavy snow that fell on November 13 causing feed to be rather hard to obtain until November 19 when a high wind blew the ridges bare. All lots made gains in the period December 13 to January 14 as the weather was fairly mild and feed (grass)

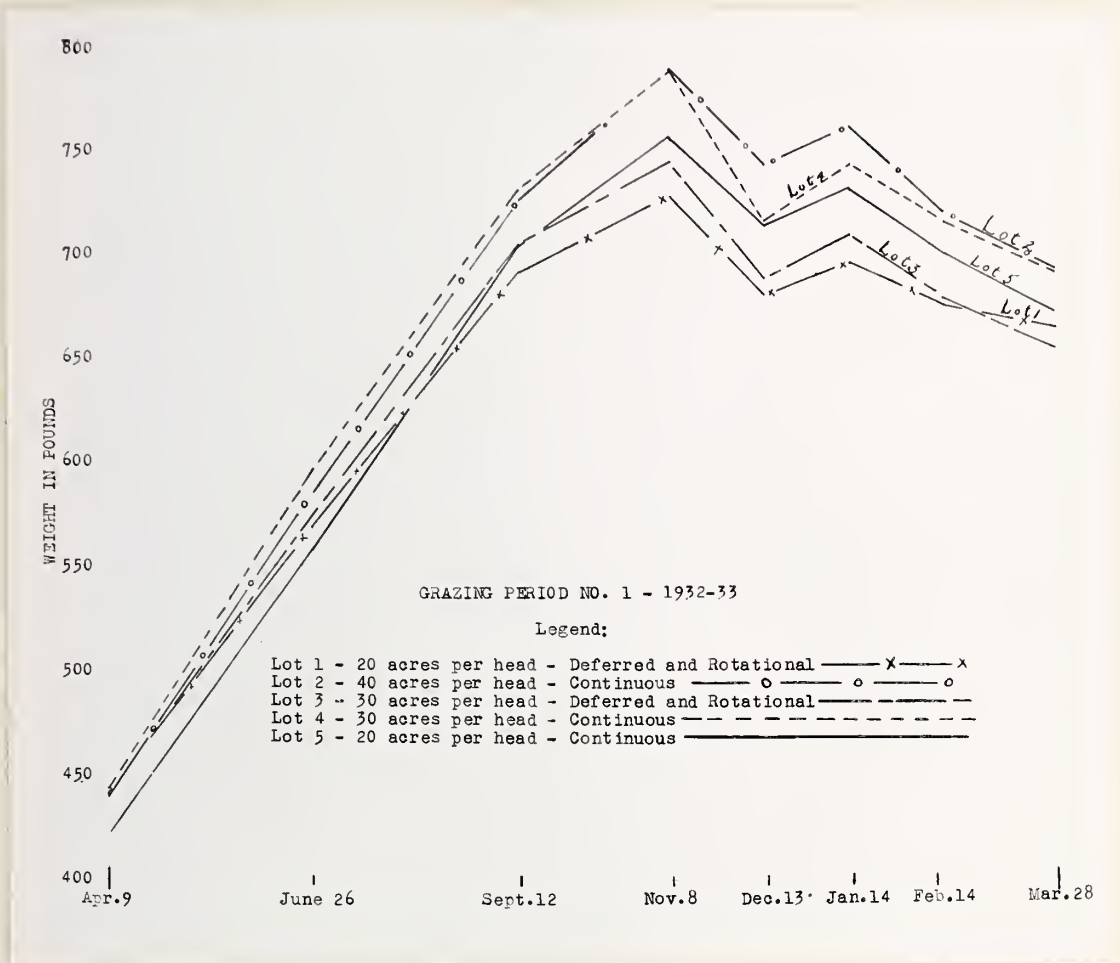

Plate II - Showing the trends in growth curves of the various lots during Grazing Period No. 1.

well exposed. The remainder of the winter season was marked by slight losses in weight by all lots. During February a short cold spell necessitated the feeding of all lots in a coulee bottom for four days. During the entire season feeding was necessary on only five days. An average of 75 pounds of native hay was fed per animal during this period.

The average seasonal gains (April 9 to November 8) of lots 1, 2, 3, 4, and 5, the 20 acre deferred and rotational, the 40 acre continuous, the 30 acre deferred and rotational, the 30 acre continuous, and the 20 acre continuous, respectively, were 282 pounds, 334 pounds, 300 pounds, 330 pounds, and 330 pounds. There was a significant difference between the gains made by these lots during this period that could be attributed to treatments (Table I, Appendix I). Though the average gain of neither lot 2, 3, 4, or 5 differed significantly from the mean gain for all lots, the gain of lot 2 was significantly higher than that of lot 3. The gains of lot 1 were significantly lower than both the mean gain of 316 pounds for all lots and the average gain of each of lots 2, 4, and 5.

The average losses of each of the lots 1 to 5 for the winter season (November 8 to March 28) were 62 pounds, 85 pounds, 89 pounds, 86 pounds, and 83 pounds respectively (Table VII, Appendix I). There were no significant differences between the average losses of any particular lot

nor did the average loss of any lot differ significantly from the mean loss for all lots.

Generally this was a very favorable year for the cattle industry.

Forage Reports

The fields used in the experiment are dominated by low growing perennial grasses, other vegetative forms comprising only some 25 per cent or less of the total vegetative cover (18), excluding Selaginella densa.

The six principle grass species are, in order of importance in the range cover, Bouteloua gracilis, (blue grama grass), Stipa Comata (spear grass), Agropyron smithii (Western wheat grass), Koeleria cristata (June grass), Poa secunda (Sandberg bluegrass), and Carex filifolia (Thread leaved sedge or niggerwool). These constitute about 90 per cent of the total grass cover. Principal among the other herbaceous species that make up the range flora are the sages. Of these artemisia frigida, Artemesia gnapholodes (dwarf sage brush), are the most prominent and of least value to cattle. They are about 20 per cent utilized by sheep (19) in Oregon and Washington, but this is a very conservative estimate for southern Alberta. Eurotia lanata (silver sage) and Atriplex nuttalli (salt sage) are also components and form a valuable part of the winter forage.

At the conclusion of the grazing season estimates of the forage carry over were made on the various fields. Those grazed by lot 1 had an average carry over of 30 per

cent, those by lots 2, 3, 4, and 5, 40 per cent, 39 per cent, 30 per cent, and 32 per cent respectively. Estimating a normal carry over (Estimation of Forage Crops Division of the Station) to be approximately 35 per cent, the fields grazed by lots 1, 4, and 5 were slightly but not seriously overgrazed.

Unfortunately, no data has been kept in any of the years on the utilization of the individual species of forage plants in the fields.

Grazing Period No. 2 - 1933-34

Seasonal Notes

The months of April and May were fairly cool months with a fair amount of precipitation. June was warm with somewhat less rainfall than fell in the previous month but some 1.87 inches were recorded. July was hot and dry with practically no rain. August was favored with considerably more rain than had fallen on the average of the five years previous. The weather in September was generally fair and clear though some rain and snow fell in the latter part of the month. With the exception of a few snow flurries in October the weather was generally good throughout this month and the month of November.

A light fall of snow (four inches) was recorded in the early part of December. This was followed by several smaller falls within a few days. On December 20, a chinook melted the snow from the ridges and higher ground, but the remainder of the prairie was left covered with ice

and crusted snow. The remainder of the month was marked with continual cold and bitter east winds. On December 23 a severe blizzard occurred but lasted only part of a day.

The weather moderated in early January and this month and February were mild and open. Chinooks occurring during the latter part of January removed most of the snow. March weather was variable with several snow storms and cold spells of short duration. There was considerable wind during this month.

Progress Report

Steady gains were made by all lots from March 28 to September 8 as shown on the graph, Plate III. Individual weights, taken periodically throughout the summer season, together with the seasonal gains of the animals in the various lots are shown in Tables II and VIII, Appendix I. The most rapid gains were made by all lots in the fore part of this period as was the case in the previous year. There was little increase in the average weights of the lots from September 8 to November 10. This was likely due in part to the stormy weather experienced in October necessitating removal of the cattle from the capacity fields to winter pasture on October 20. The period November 10 to December 11 was marked by slight gains. During the next month, December 11 to January 13, decided losses in weight occurred in all lots. This was most probably the result of the severe cold spell and the blizzard experienced

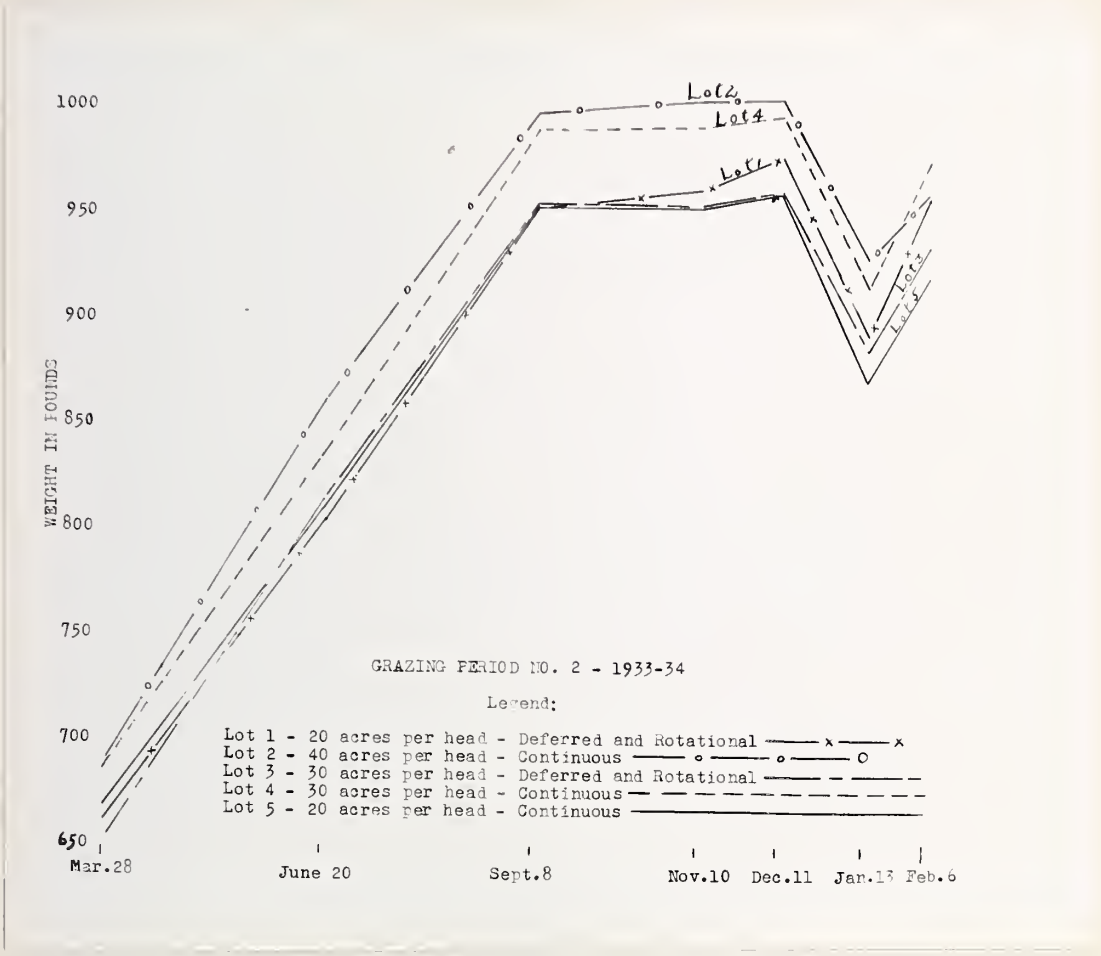

Plate III - Showing the trends in growth curves of the various lots during Grazing Period No. 2.

during this period. The cattle were moved from the winter field on January 16, as feed was becoming scarce in this pasture and it was felt there was only sufficient feed for the other experimental stock.

The heavy gain from January 13 to February 6 may be accounted for in part at least by the cows advancing in pregnancy during this period. As it was felt the cows might be injured, they were not weighed again and the weight taken on February 6 was recorded as the final winter weight and initial summer weight.

The 50 heifers then in the test were tested for contagious abortion on February 15 by Dr. Bankier of the Veterinary Research Station, Lethbridge. There were no reactors.

The mean gain for all lots of 304 pounds was slightly lower in the period March 28 to November 10 than it was for the corresponding period in the previous year. Average gains of the lots 1 to 5 inclusive were 303 pounds, 316 pounds, 305 pounds, 306 pounds, and 286 pounds respectively. There was no significant difference between the gains of the various lots due to treatments nor did the average gain of any one lot differ significantly from the mean gain of all lots. This could be expected as there had been no significant difference in the losses experienced in the various lots during the previous winters, making it such that no lot had a particularly heavy handicap to overcome.

The mean loss for all lots during the winter season

of 1933-34 was less than it was for the same season of 1932-33, being some 22 pounds as compared to 82 pounds for the previous year. The average loss of each of the lots 1 to 5 inclusive was 3 pounds, 43 pounds, 18 pounds, 15 pounds, and 31 pounds respectively. The average losses of lots 3 and 4 differed significantly from that of lot 2, the average loss of lot 2 being higher, but the loss of no lot differed significantly from the mean loss of all lots (Table VIII, Appendix I).

Forage Reports

The average carry over for the fields grazed by lots 1 to 5 inclusive, were 25 per cent, 40 per cent, 36 per cent, 34 per cent, and 35 per cent respectively. The grass started well in all fields and made good growth during April and May but burned badly during the hot weather of June and July. The effect of this was shown in the 20 acre deferred and rotational plan. The field grazed during most of this period in August was very closely grazed, having only a 10 per cent carry over compared to 30 per cent and 35 per cent for the other two fields in the unit. Even the sage brush was heavily pastured. This seems to indicate that where the pasture area is limited a definite rotation of grazing breaking the pasture into three fields is not helpful in making the best use of that range. The field used in the first third of the season may provide adequate range, but the field used in the second portion of the season may

provide for too little forage due to the poor growing conditions that might prevail. This will result in one or two fields of the unit being undergrazed while the remaining fields are overgrazed. Part of the range, therefore, is injured.

This deleterious effect on the pasture units was not shown in the gains of the cattle, however.

Grazing Period No. 3 - 1934-35

Seasonal Notes

Though April was very dry the grass started fairly well. May was also dry with an unseasonably hot spell in the latter part of the month. Over three inches of rain fell in June and the grass revived considerably. The scorching days of July and August burnt this new growth. A heavy fall of snow arrived late in September, resulting in some new growth which was frosted early in October. The weather in October could generally be classed as good although the latter part of this month was marked with cool drizzling days and rather raw winds. A light snow covered the ground during November and early December but the weather during this period was fairly mild.

On December 26, a cold spell set in lasting till January 27. Several blizzards brought over a foot of snow during this period. The weather moderated and was again favorable throughout February. A chinook on February 17 left much crusted snow and ice.

A severe storm occurred the first week in March and typical variable March weather prevailed during the rest of the month, snow storms and cold spells being frequent but of short duration.

Progress Report

As shown in the graph, Plate IV, the total gains of all lots in the summer season of this year were not as great as they were in any previous year. This, of course, is to be expected since many of the cows had suckling calves. Fairly consistent and rapid gains were made by all lots from May 17 to September 6. The loss of weight between September 6 and the next weighing period is probably due to the rather unfavorable weather late in October, together with a lack of forage on the overgrazed fields following a dry summer (the cows were not moved until November 19). The slight gains of lots 1 and 4 in the next period while the other lots continued to lose weight is rather unexplainable. In the period December 8 to March 12 fairly heavy losses were experienced by all lots. This could logically be accounted for on the basis of the bad weather prevailing during a part of that period, which proved very hard on stock generally.

Early in February the "capacity" cows were removed from the winter field and placed on winter pasture in a field a few miles south of the station buildings. This was done as the winter pasture was getting rather short and it was feared there would not be sufficient feed for all the

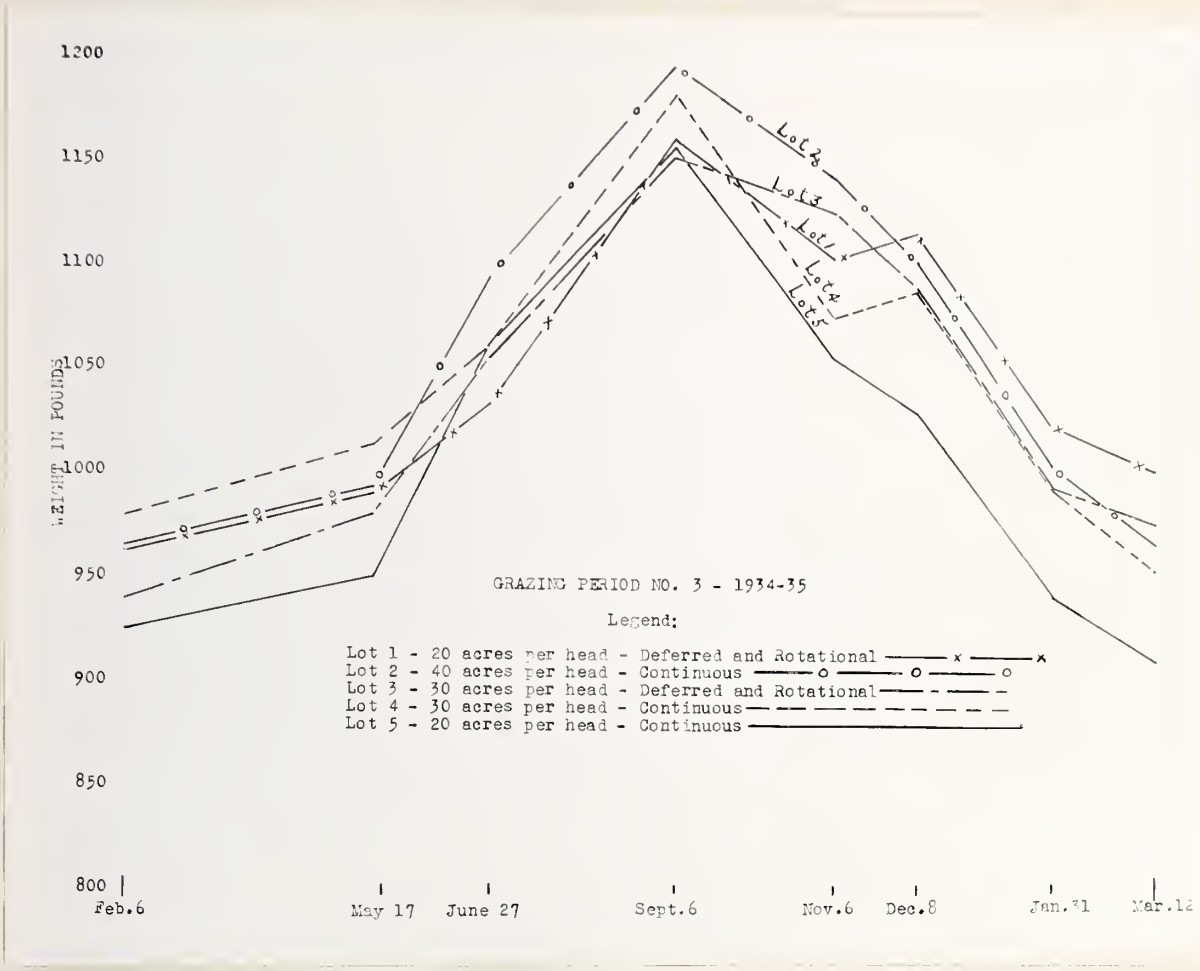

Plate IV - Showing the trends in growth curves of the various lots during Grazing Period No. 3.

experimental stock for the remainder of the winter. Six cows were too weak to make the trip and were kept at the station and fed hay. It was interesting to note that three of these were from lot 1 and one each from each of lots 2, 3, and 5. Two of those from lot 1, the same that had been fed the previous winter, and one from lot 3, had been on feed since the latter part of December.

The mean summer gain for all lots was 146 pounds. The average gain of each of the lots 1 to 5 inclusive was 139 pounds, 176 pounds, 184 pounds, 94 pounds, and 128 pounds respectively (Table III, Appendix I). In spite of the fact that, as seen in Table I, Appendix II, there was a smaller percentage of calves, which also reached a lighter weaning weight, from lot 1 than any of the other lots, this lot did not behave significantly differently from any of the other lots as far as gains were concerned. There was no significant difference between the mean gains of the various lots for the summer season nor between that of any one lot and the mean gain for all lots.

The first calves were born to the cows this season. The calves of lot 2 were outstanding from point of view of size, weight, and general condition (Table I, Appendix II). One calf was born dead in lot 1 and one cow in this lot aborted her calf early in February, the latter likely due to an injury resulting from her emaciated state. Two calves were lost during the year from lot 4 - one from septicemia

and one from black leg, the latter occurring shortly before branding. Two of these losses (lot 1) could be directly attributed to the plane of nutrition on which the cows existed.

There was a very significant difference between the mean losses of the various lots in the winter season, November 6 to March 12. The mean losses of these lots, 1 to 5 inclusive, were 101 pounds, 175 pounds, 148 pounds, 120 pounds, and 144 pounds respectively (Table IX, Appendix I). Lot 1 showed significantly less average loss than any of the other lots, excepting lot 4, and this was significantly less than the mean loss of 139 pounds for all lots.

The average loss of lot 2 was significantly higher than the losses in lots 1, 4, or 5 and than the mean loss for all lots. The mean losses of lots 3 and 5 were similar and not significantly different from the mean loss of lot 4 or the mean loss of all lots.

Generally it appears the lots making heavy summer gains suffer the heaviest winter shrinks.

Forage Reports

The average carry over of the fields grazed by the five lots 1 to 5 inclusive were 14 per cent, 32 per cent, 28 per cent, 28 per cent, and 20 per cent respectively. All of these were below the 35 per cent estimate considered necessary to properly maintain a normal range cover. The fields grazed by lots 1 to 5 were very closely grazed. The dry summer had, of course, seriously aggravated all of these

overgrazed conditions. This situation emphasizes the necessity of a good margin in stocking the range in order to be able to bring cattle through the less favorable years successfully.

Grazing Period No. 4 - 1935-36

Seasonal Notes

April was a cool, backward month with several snow flurries and generally cool, damp weather. Following a heavy snow storm which occurred early in May the weather was generally fair for the rest of the month. June was a drier month than usual and some burning of the grass, already late in starting due to the cool spring, was noticed by June 25. Several thunder showers occurred in the first three weeks of July culminating in a two inch rain on July 21. The remainder of this month, as well as August and most of October, was hot and dry with the occasional thunderstorm. The grass was completely cured by the middle of August.

There was a severe cold spell with a heavy snow during the last few days of October. Cold weather with sub-zero temperatures prevailed throughout the first ten days of November. The snow soon melted and the rest of the month, as well as most of December, was mild and free of snow. A light fall of snow was recorded on December 23 but the weather remained fair until January 4. The temperature remained steadily below zero until the end of this month with the exception of a slight chinook on January 22 that left the

snow badly crusted. It was bitterly cold during the last seven days of this month. February was the most severe month ever experienced in southern Alberta. Temperatures were never above zero for 28 consecutive days. An unusual amount of wind intensified the cold. The cold spell broke on February 29 with a chinook that cleared the ground in a few places within the next three days. Most of March was very favorable. The last four days, however, were cold and stormy.

Progress Report

The cattle were moved to the capacity fields on April 12. As can be seen by the chart, Plate V, all lots continued to lose weight after the March 12 weighing. The grass in the pasture had not started well due to the cold weather. Two of the cows in lot 1 died as a direct result of calving. Lot 1 failed to show gains in weight after the June 24 weighing. This was probably due to the emaciated condition of these cows following the winter feeding period. Eleven cows and calves were brought in during June from the Gilchrist Brothers range herd to replace the cows in all lots that had died or failed to calve. The cows replaced were numbers 10, 11, 17, 18, 22, 24, 30, 40, 41, 51, and 52. Fairly consistent gains were made by lots 2, 3, 4, and 5 during the period May 22 to June 24 and by all lots from then until September 5. The shrink suffered by all lots in the period September 5 to November 2 was the result of the cold spell that broke during the latter part of October.

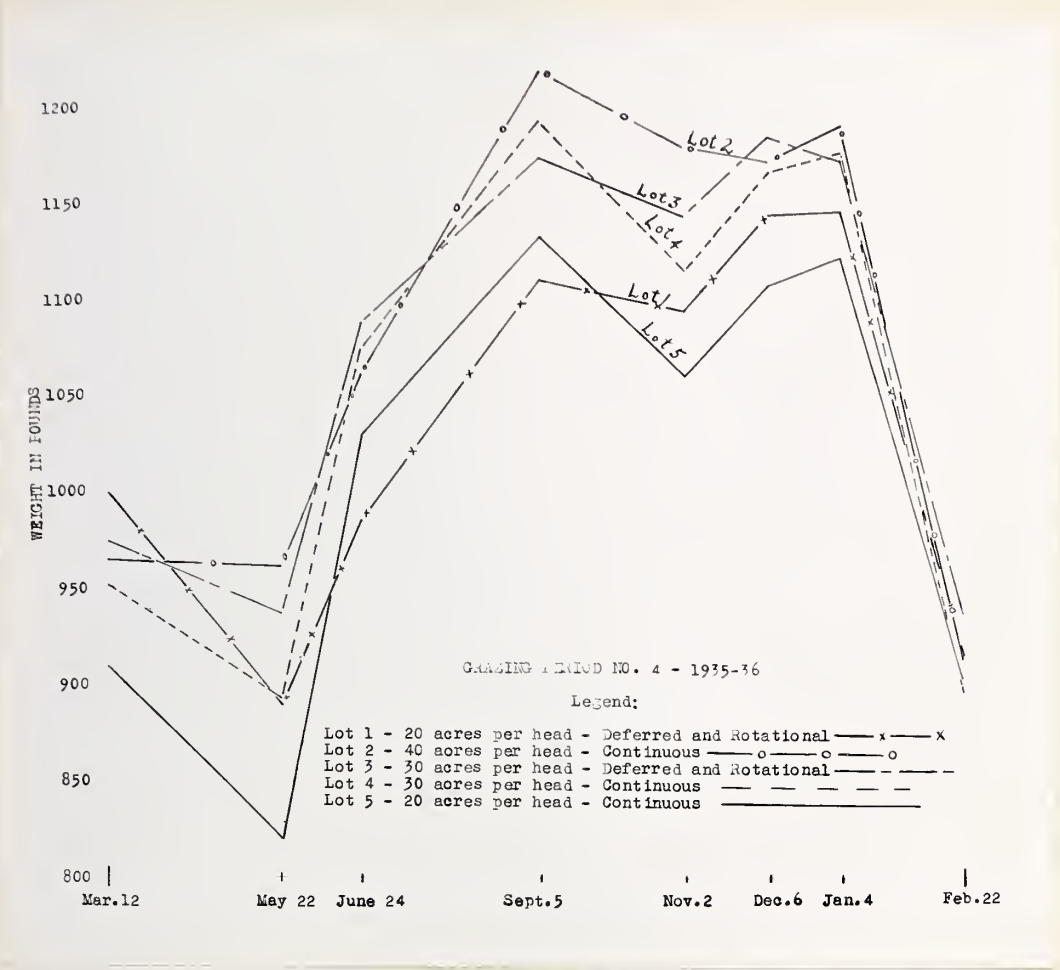

Plate V - Showing the trends in growth curves of the various lots during Grazing Period No. 4.

Fairly good total gains were made by all lots during the period November 2 to January 4. During the next period (January 4 to February 22) severe losses were experienced by all lots in what was one of the hardest winters on stock ever witnessed in southern Alberta. A total of 17 cows were fed in this period. The percentages from the various lots requiring extra feed were as follows: lot 1, 50 per cent; lot 2, 12.5 per cent; lot 3, 44.4 per cent; lot 4, 25 per cent; lot 5, 62.5 per cent (20). The effect of insufficient summer pasture on wintering costs is quite evident from these figures.

The mean summer gain of 158 pounds for all lots was considerably lower than in previous years (Table IV, Appendix I). All lots, however, had 100 per cent calf crops which they reared to weaning age (considering only the cows still being used in the experiment in 1938). This may easily account for their failure to make large gains. Average gains of the five lots were 92 pounds, 209 pounds, 163 pounds, 159 pounds, and 148 pounds respectively. The gains of lots 1 and 2 were significantly different from one another but not from those of the other three lots. The average gain of no lot was significantly different from the mean gain of 158 pounds for all lots.

Average weaning weights of the calves from the various lots do not show particularly big differences. Lots 1 and 3 have the lowest, being some 57 pounds and 61 pounds, respectively,

lower than lot 4 (Table II, Appendix II). They were a much better lot of calves than the 1934 crop and out-weighed them considerably.

The 40 acre lot, which had a considerable reserve of flesh, lost most heavily in the winter. All lots showed average losses below the average gains they had made during the previous summer. Lot 1 lost nearly twice as much as had been gained during the previous summer. The mean loss for all lots was 206 pounds. The average losses of the various lots were 176 pounds, 262 pounds, 202 pounds, 217 pounds, and 154 pounds respectively (Table X, Appendix I). The average losses of lots 1 and 5 were significantly lower than the average loss of lot 2. The loss of lot 5 also differed significantly from that of the 30 acre continuous lot. The 40 acre lot was the only lot showing a significant difference in loss from the mean for all lots. It was considerably higher. The inadequacy of the range of lots 1 and 5 is quite definitely indicated this year both in the summer gains and in the failure of the cattle to withstand the winter without supplemental feeds.

The only two deaths occurring in the lots this year were in lot 1. While these were caused by calving difficulties, they may be attributed to the low plane of nutrition on which the cows had existed during the three preceeding years.

Forage Reports

The average carry over of the pastures grazed by each of the five lots was 16 per cent, 38 per cent, 28 per cent, 33 per cent, and 19 per cent respectively, again showing the same residual effect of overgrazing on the pasture as was found in the performance of the livestock.

Grazing Period No. 5 - 1936-37

Seasonal Notes

The summer season of 1936 was the poorest season experienced since the commencement of the capacity project. Early April was very cold with below zero temperatures prevailing for a week. A heavy fall of snow covered the ground. Sufficient moisture fell during the month and with the warmer days in the latter half of the month the grass started well. This growth that looked so promising by the end of the month received a serious set back and the forage ceased to grow after May 20. Hot weather began to burn the grass in the latter part of this month. Early June rains revived the range but the last ten days of June and the month of July were extremely hot with many dry winds. The grass withered completely. Though some rain fell in August, this came mostly in the form of light showers. It was a cooler month but there was little growth of forage. The month of September and the first 18 days of October were fair and dry. On October 19 a six inch fall of snow was recorded. Low temperatures prevailed during the latter part of this month.

The first week of November was cold and stormy but the rest of the month was exceptionally fine, the snow having melted. Stormy weather was the rule rather than the exception for the first ten days in December. Two weeks of fine weather followed but the month closed cold. From December 2 until March 1 conditions were exceptionally severe. Eighteen inches of snow covered the range and the temperature was below zero for 40 consecutive days. There was more wind than usual during that period. Some 10,000 miles of wind, 2,000 miles above normal, were recorded in the month, January 1937, by the wind recorded at the Station. This drifted much of the snow into the coulees eliminating practically all the possibilities of cattle grazing or obtaining shelter.

On March 1 it warmed up and some of the snow melted, exposing the grass. This lasted but a few days as on March 20 it again turned cold. Six inches of snow fell in the next week.

April weather was generally fair and moderately warm.

Progress Report

Plate VI presents a chart showing the average weights of the cattle taken periodically from February 22, 1936, to March 6, 1937. The February 22 weight was taken as the final winter weight and initial summer weight due to the fact that the cows were very heavy with calf and it was felt they might be injured if weighed at a later date.

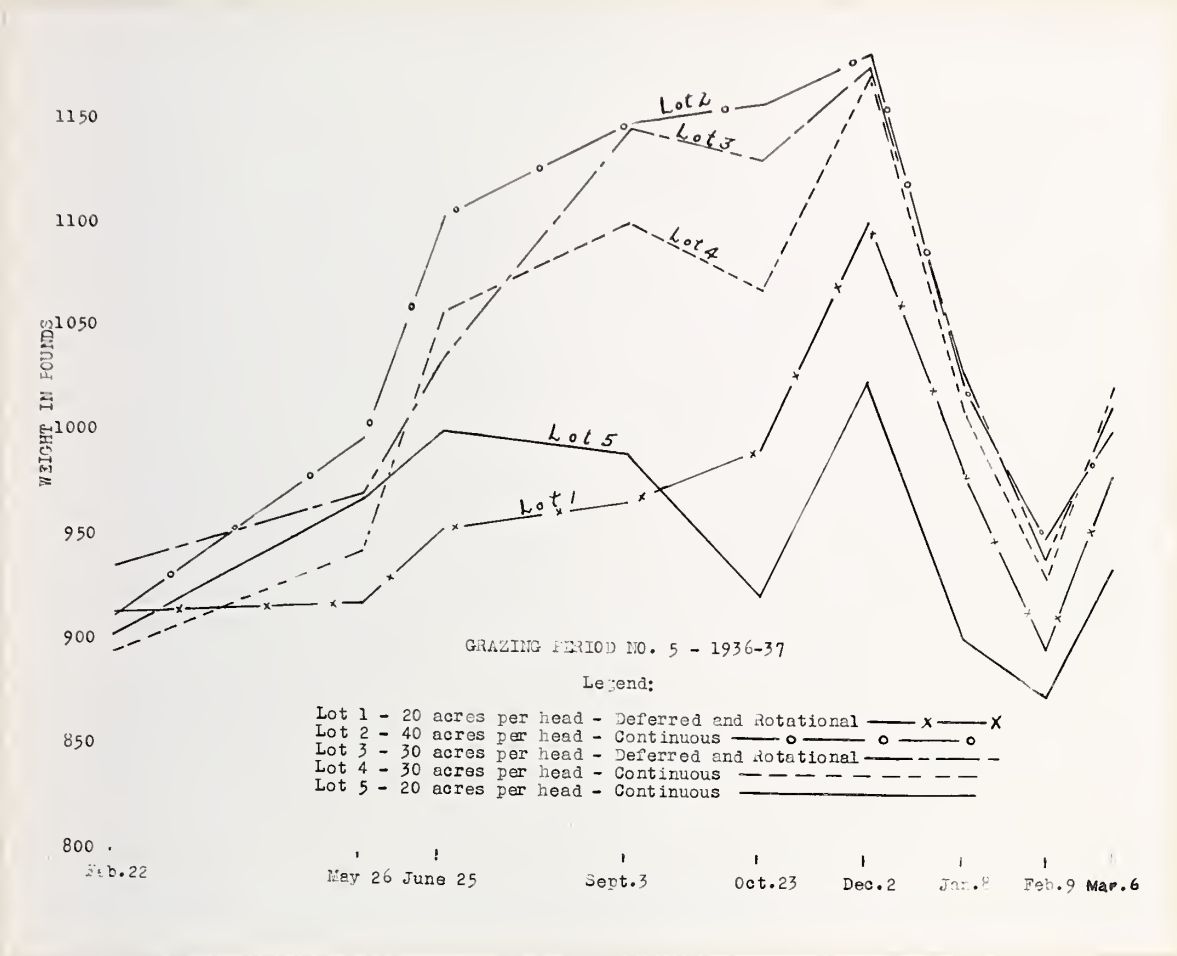

Plate VI - Showing the trends in growth curves of the various lots during Grazing Period No. 5.

Two year old heifers were used as replacements for the cattle that had died or had been discarded.

All lots made gains from February 22 to June 25 though the gains of lots 2, 3, and 4 were considerably better than those of lots 1 and 5. The dry year and consequent inadequate summer range after a severe winter left its mark on the 20 acre lots. Lot 5 started to lose in weight after the June 25 weighing and had lost considerably by October 23. Though lot 1 made a gain, this was very slight. Lots 1 and 2 were the only lots making consistent gains till December. The decided losses recorded in lots 3, 4, and 5 and the retarded gain of lot 2 for the period September 3 to October 23, were likely due to the cold storm that occurred during a part of this period. Lot 1 experienced a more rapid average gain during this period than it had during any time since June 25. This is unexplainable.

Cow no. 38 discarded from lot 3 during this season, was shipped as a "canner" due to a malignant eye growth that had developed since the middle of the previous summer's grazing season.

All lots benefited by the fine weather that prevailed during most of the period October 23 to December 2 and made fairly substantial gains. All lots suffered severely in the extremely cold weather of late December, January, and early February. It was necessary to take some of the cows in every few days during this period and provide feed and shelter for them. Sixteen head were taken in during

the period January 5 to February 1. The cows remaining in the winter field were fed along a coulee bottom from January 18 to March 18. The gains shown by all lots during this period in spite of the cold weather were probably due to this feed that consisted of from 2 to 3 pounds of oil cake and 5 to 10 pounds of straw per head daily.

There was great variability in the individual gains recorded the animals for the summer season. Individual gains ranged from -102 pounds in the 20 acre continuous lot to 362 pounds in the 40 acre lot. There was a very significant difference between the average gains of the various lots. The average summer gains of the five lots were 79 pounds, 246 pounds, 197 pounds, 177 pounds, and 22 pounds, considerably lower for lots 1 and 5 than for the other lots, showing the effect of a severe winter followed by a dry summer on the thrift of these lots. The other three lots seemed to have weathered the hard winter sufficiently well and in spite of the dry summer seemed to have had enough forage in the larger pastures to make fairly good seasonal gains. The average gains of the two 20 acre lots differed significantly from the mean gain of each of lots 2, 3, and 4. The average gain of lot 2 was significantly higher and that of lot 5 significantly lower than the mean gain of 155 pounds for all lots (Table V, Appendix I).

These differences become even more significant when the record of the calf crop for that year is studied (Table

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III, Appendix II). Lots 1 and 5 weaned the lightest calves on the average and excepting lot 4 also weaned the smallest percentage of calves. Of the four calves that died, one was lost from lot 3 because of premature birth; one was born dead from lot 4, another in this lot died in July, (cause unknown); and one died from lot 5 of an unknown cause. One cannot definitely conclude, therefore, that any of these losses were directly due to the plane of nutrition of their mothers.

Photographs of representative cows of the various lots were taken in October of this year and reproductions of these appear in Plates VII, VIII, IX, X, and XI. Not all of these cows were in use at the completion of the experiment in 1938 but the illustrations indicate the effect of the various grazing capacities on the growth and thrift of the various lots of cattle up to that time.

The winter performance of the cows in the various lots this year is very peculiar. The average losses of the lots 1 to 4 (inclusive) were 10 pounds, 153 pounds, 114 pounds, and 44 pounds respectively, while lot 5 showed an average gain of 13 pounds over the whole season. This lot, however, had fared so badly during the previous summer that even with this gain they were some 50 pounds lighter than the next lowest lot at the conclusion of the winter season.

The mean loss for all lots during this season was 69 pounds (Table XI, Appendix I). No lot had an average loss that differed significantly from this mean. The loss in

Plate VII - Showing individual cows representative of Lot 1.

Plate VIII - Showing individual cows representative of Lot 2.

Plate IX - Showing individual cows representative of Lot 3.

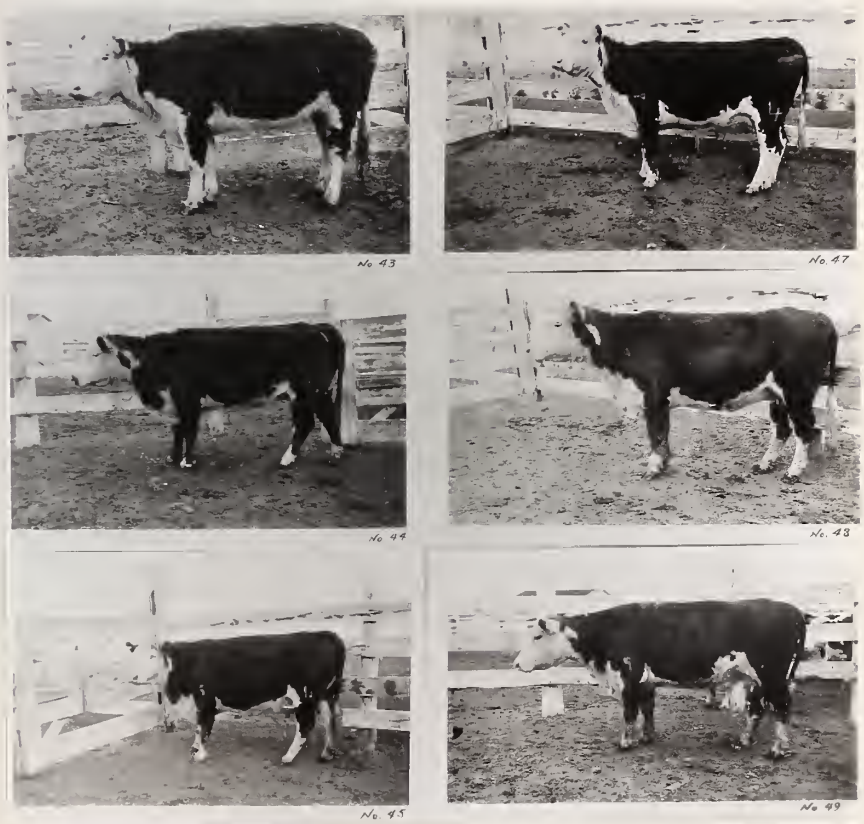

Plate X - Showing individual cows representative of Lot 4.

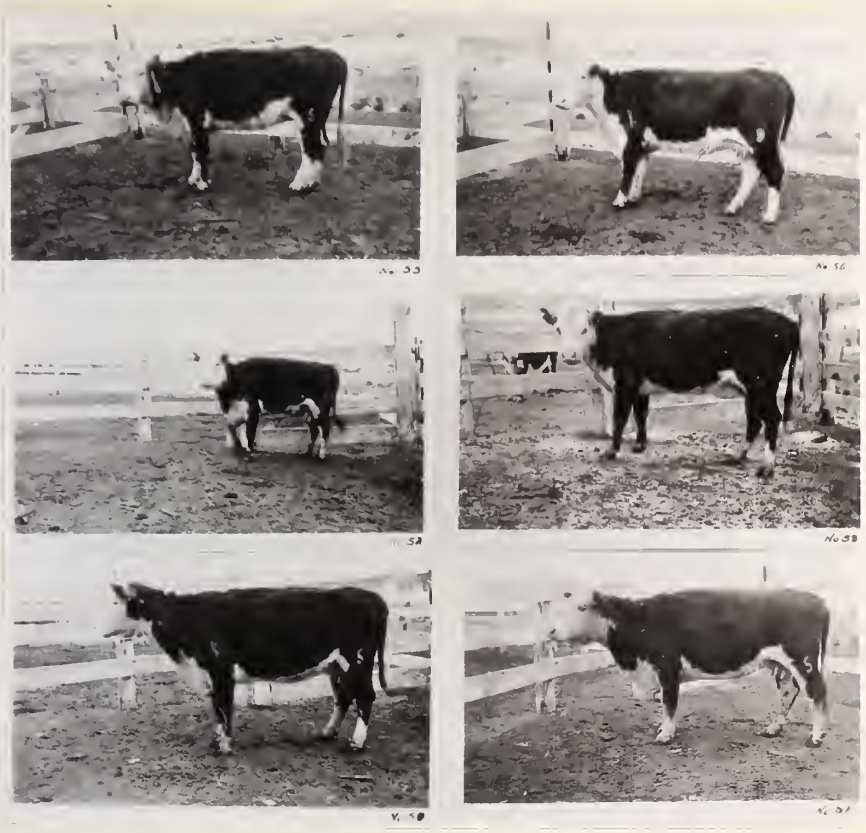

Plate XI - Showing individual cows representative of Lot 5.

lot 2 was as usual significantly greater than lots 1, 4, or 5. Lot 3 showed a significantly greater loss than lot 1 but no significant difference from other lots.

These differences become even more significant if the winter cost of supplemental feeds is considered. These were, for lots 1, 3, 4, and 5: $3.89, $2.97, $3.18, $3.15, and $5.60, respectively (20).

Forage Reports

The average carry overs in the fields grazed by the five lots were 7 per cent, 22 per cent, 13 per cent, 12 per cent, and 7 per cent respectively. All fields were quite uniformly pastured though seriously overgrazed. The fields grazed by lot 1 were so severely pastured that the turf was much trampled by the cattle in their search for food.

Three successive dry summers followed by the severe drought of the past summer have produced little forage. This, coupled with overgrazing in the smaller fields, has devastated the carry over of these pastures seriously.

Grazing Period No. 6 - 1937-38

Seasonal Notes

A sudden warm spell commencing April 7 precipitated a heavy run off. This heavy run off was rather a local occurrence, however, extending for only 40 miles in every direction from the Station. Very little water soaked into the frozen ground during this thaw, however, the grass received a good start in early May, but the high winds during

the latter part of this month dried the soil and growth was almost at a stand still early in June. On June 12, 1.3 inches of rain occurred, followed by showers of .3 inches on June 16 and 22. These rains produced a remarkable growth of grass. Late growing species such as blue grama grass made the best stand in years. Local range conditions were the best since 1932. July was favored with several showers helping the grass to continue to grow as neither this month nor the next were marked with excessive heat. September moisture was above normal and green grass was available throughout all this month and part of October. A very open fall was experienced.

After freeze up on November 22, ten days of cold weather with four inches of snow were followed by a chinook on November 26 which cleared the snow. The months of December and January were, for the most part, mild and cattle grazed out continuously, no supplemental feeding being found necessary. The first three weeks of February were cold with heavy snow falls. Mild weather prevailed from February 23 to March 28. Most of the snow was gone by that time.

On the evening of March 28 the most severe storm in 40 years struck the country. The wind reached abnormally high velocities. A maximum of 83 miles per hour was registered. For three hours the velocity averaged 70 miles per hour and for 18 hours it averaged over 60 miles per hour.

Generally the winter was an exceptionally fine one. The severe storm in March, however, proved very hard on stock.

Progress Report

The drought of 1936 and the severe winter of 1937 left the lots grazing on the lower acreages in very poor condition. On April 13 the lots were moved back to the summer pastures. Owing to the late spring and consequent shortage of forage in the field grazed by lot 5, this lot was fed 3 pounds of oil cake per head daily from April 28 to May 16. This feed was included in the winter cost figures for 1936-37. One cow in this lot had died (No. 55) on January 21 due to some stomach disorder. Another, No. 54, had died during April. Both losses could be traced to the extremely low plane of nutrition.

The feeding of this supplement probably accounts for the ability of lot 5 to gain equally as well as the thriftier lots (2, 3, and 4) during the period March 6 to June 26 (Plate XII), while lot 1 failed badly. All lots show fairly good gains from then until September. Lot 1 responded particularly well to these months of good grass growth.

The cows were moved to the winter pasture on November 2. The lots do not show the same general trend in gains and losses during the period November 3 to December 3. The cold weather and snow that prevailed during part of this period would be expected to shrink all lots of cattle some-

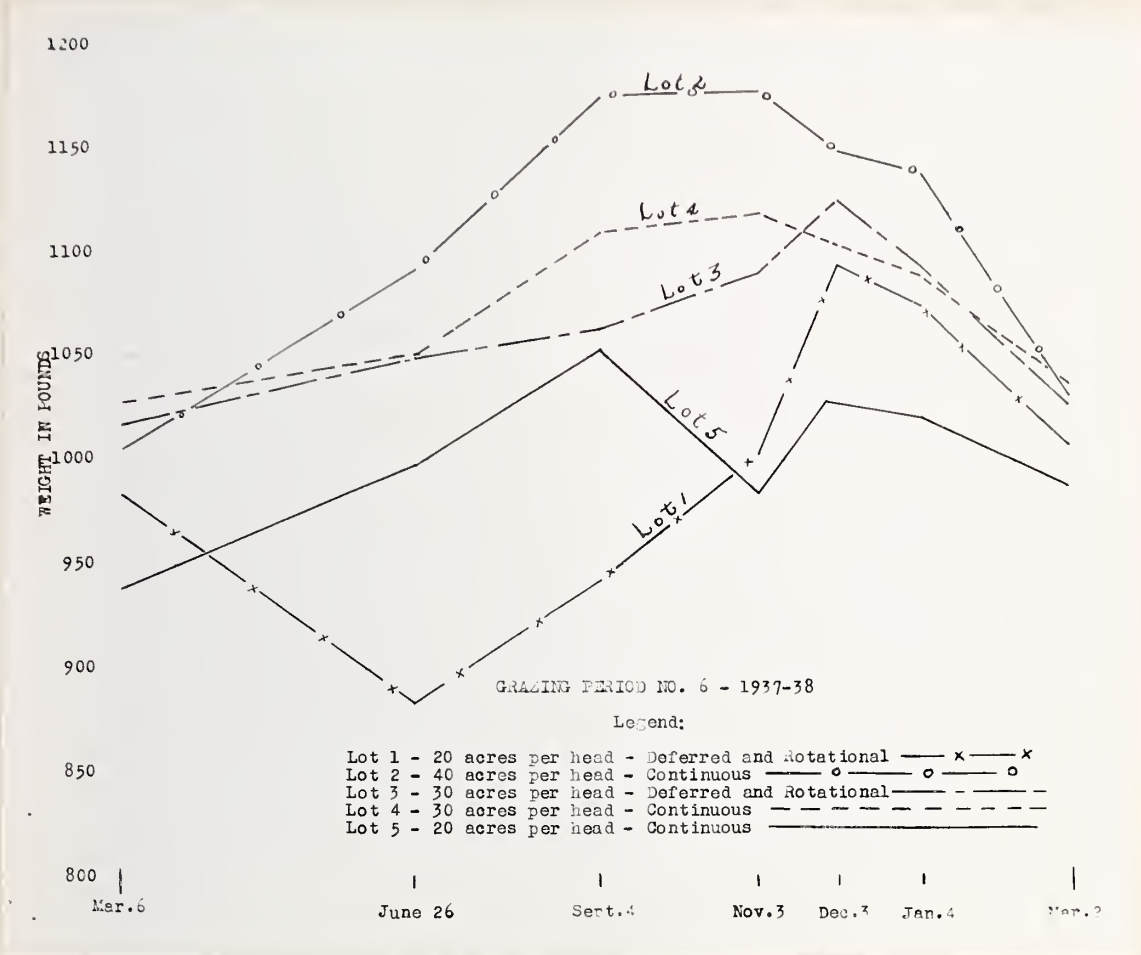

Plate XII - Showing the trends in growth curves of the various lots during Grazing Period No. 6.

what. Lots 2 and 4 did show some loss in weight but the other three lots actually gained. Losses, though not extremely great, were experienced by all lots from December 3 to March 2. These losses may be accounted for by the cold spell from February 5 to 22. Supplemental feed was provided all lots nearly every day during this period. The weight on March 2 though not recorded on the date the cows were moved to summer pasture, was taken as the final winter and initial summer weight. This was done to avoid injury to the cows already well advanced in pregnancy. The cows were not turned out to summer pasture until April 21. During the intervening time cows No. 14 and 33 perished in the blizzard of March 29.

Extra feed was given 3 cows from lot 5 and one each from each of lots 3 and 4.

The average gains made by the various lots for the summer season were 21 pounds, 172 pounds, 73 pounds, 102 pounds, and 46 pounds respectively. These were, in most cases, the lowest ever recorded in any of the lots for this period throughout the six years in spite of the fact that the best growth of grass since 1932 covered the range. The average gain of lot 2 was again significantly higher than those of lots 1 and 5 and was significantly higher than the mean gain of 89 pounds for all lots. Lot 4 was also significangly higher than lot 1 in their average gains but did not differ significantly from the average gain of

lot 2 or the mean gain for all lots (Table VI, Appendix I). The difference between the average gains of lot 5 and the other lots is even more significant when it is considered that this lot was fed oil cake during the early part of the season.

There was a very marked difference in the percentage calf crops from the various lots. Lot 1 had a 66.7 per cent calf crop, while lots 2, 3, and 4 each had 87.5 per cent calf crops, and lot 5 had a 100 per cent calf crop. Mortality was nil among the calves this season. The weaning weights of these calves were even more significant. Lot 1, as in two of the three previous years, weaned the lightest calves. These were very poor individuals. Lot 2 had the heaviest calves, averaging 112 pounds heavier than those of lot 1. The other lots had weights of various gradations between these but all were at least 50 pounds heavier than lot 1 (Table IV, Appendix II).

The winter weights of the cows show less loss than in previous years. The mean loss for all lots was 66 pounds as compared to 68, 206, 139 for the three previous winters. This was undoubtedly the result of the generally mild winter. The average losses of lots 2, 3, and 4 were 145 pounds, 63 pounds, and 90 pounds respectively. Lots 1 and 5 gained an average of 5 pounds and 4 pounds respectively. The average gains of lots 1 and 5 were a significant contrast to the losses of the other lots. The loss of the 40 acre per head

lot also showed a significantly greater average loss than the other lots, excepting lot 4, or the mean loss for all lots. (Table XII, Appendix I).

With the exception of the low figure for lot 1, the lots generally show the same comparison of cost figures for supplemental winter feeds as they did in other years. Lots 1 and 2 were cheapest with $1.78 per head, lots 3 and 4 next at $1.90 per head, and lot 5 highest at $2.28 per head.

Forage Reports

The average carry over of the fields grazed by the various lots were 16 per cent, 20 per cent, 18 per cent, 15 per cent, and 10 per cent respectively. Some sections of the units grazed by lots 1 and 3 were 100 per cent utilized from the stockman's point of view, as was the field grazed by lot 5. These were the sections that were grazed in the fall third of the summer pasture season.

Comparing these carry overs with those of 1932, it will be seen that after a period of dry years several good seasons will be required to build up a normal carry over of grass, especially on the fields grazed at the lower acreages per head.

Summary of the Period April 9, 1932, to March 3, 1938

Summer Gains

Considering the recurrent droughts that marked the years 1933, '34, '35, and '36, the period from 1932 to 1938 inclusive was generally far below the normal that would be

expected. There was some variability between the years as even these drought years differred in their severity, 1936 being extremely dry.

There was a significant difference in the year to year summer gains of all lots (Table XIII B, Appendix I). This can be seen from the yearly means for all lots which were 316 pounds, 304 pounds, 146 pounds, 158 pounds, 155 pounds, and 89 pounds respectively.

Over the whole of the six year period, there was a significant difference between the gains of the various lots. It will be recalled that in 3 out of the 6 years, there were also significantly different gains made by the various lots. These differences between lots are attributable to their treatment; the condition of the cattle when turned to the summer pasture, i.e. their thrift or ability to forage for themselves; and the summer growing conditions and consequent forage available for their use. It would be expected that the years of drought would cause the differences in the gains of the various lots during the years above normal in forage production (i.e. that there would be an interaction between the years and the treatments). This was not supported by the statistical analysis (Table XIII B, Appendix I).

Winter Losses

Generally, the winters covered by the period of the experiment could be considered from their effect on range livestock to be more severe than the average expected over a period of years. There was much variability in the prevailing

weather conditions of those winters. This is shown in part by the differences between mean losses for all lots in the various years. These were 82 pounds, 22 pounds, 139 pounds, 206 pounds, 68 pounds, and 66 pounds respectively. While it is to be remembered that the summer gains contributed to the degree of these losses (i.e. unless the animals had made good summer gains, they would not have the flesh to lose in heavy winter losses), the nature of the winter weather may be cited as the direct cause. This very significant year to year difference in the losses of all lots is also borne out by the statistical analysis. (Years, Table XIII A, Appendix I).

In five of the six years significant differences were noted between the losses recorded for the various lots (Yearly progress reports). Considering the six years as a whole, there was also a significant difference between the losses of the various lots (Table XIII A, Appendix I). These differences can be attributed to the experimental treatments or different plane of nutrition on which the animals existed. Since all lots normally received the same ration in the winter, this must mean the summer planes of nutrition. These lot to lot differences were not affected by those conditions that caused the year to year differences (Interaction - Table XIII A, Appendix I).

Mortality

Four cows were discarded from Lot 1 during the six

year period. Two of these were sold as beef due to their failure to get with calf. Two died as a direct result of calving. The latter two deaths could be, as previously stated, directly attributed to their plane of nutrition. Lot 2 had two discarded during the period. Both were cows sold for beef because of failure to get with calf. Of the cows discarded from lot 3, one was sold because of a malignant eye growth and the other because of her failure to get with calf. The two cows sold from lot 4 were non-breeders. Two cows were sold from lot 5 for the same reason. The other two died as a direct result of the starvation diet on which they existed.

The only actual losses were from lots 1 and 5. These losses could be directly attributed to the low plane of nutrition on which they existed during the summer grazing season.

Calf Crop

The summary of the calf crops appearing in Tables I to IV inclusive, Appendix II, will serve to show the effect of the summer planes of nutrition on reproduction in the various lots. The number of calves born and the percentage weaned during the four years 1934 to 1937 inclusive, were consistently lower for lot 1. There seemed to be no general differences evident between those of the other lots for the same period.

The average weaning weights of the calves from the

cows of lot 2 were consistently greater year after year, with the exception of one out of the four years in which lot 4 calves had the heaviest weaning weight. Lot 4 calves had the second highest weaning weight, with the exception of that one year in which it was the highest. The calves from lot 1 had the highest average weaning weight in three out of the four years in which there were calf crops. There does not seem to have been any consistent difference between the average weaning weights of each of the other lots.

The cows on the lower summer planes of nutrition generally had smaller calf crops which were lighter in weight at weaning time than the cows grazing on an abundance of forage.

Forage Reports over the Period

The following table outlines the estimated yearly carry over of the fields grazed by the various lots from April, 1932, to November, 1937.

Year	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
1932	30%	40%	39%	30%	32%
1933	25%	40%	36%	34%	35%
1934	14%	32%	28%	28%	20%
1935	16%	38%	28%	33%	19%
4-year-average	21%	38%	32%	31%	26%
1936	7%	22%	13%	12%	7%
1937	16%	20%	18%	15%	10%
6-year-average	18%	32%	27%	25%	20%

The estimates for lots 1 and 3 represent the average of

the carry overs of the three respective fields that made up the pastures of each of these lots. All the pastures showed a six year average carry over for the period, below the estimate of 35 per cent given as that required for the normal preservation of the range cover. On recalling that the three summers preceeding that of 1937 were drier than normal, and especially in view of the extremely dry year of 1936, this low average is rather expected. By excluding 1936 and considering the average of the four years previous to that, we have estimates that more closely approach the normal expected over a period of time. It is evident from these figures that the fields pastured at the lower acreages per head were seriously overgrazed. The fields grazed by the 40 acre continuous lot provided ample forage to feed the stock and leave a satisfactory carry over. The fields grazed by the 30 acre lots fall just slightly below the requirement.

Comparing the continuous and the deferred and rotational systems of grazing, there does not seem to be enough advantage in the latter where cattle are grazed at 30 acres per head to justify the extra fences necessary under the rotational plan from the point of view of range conservation.

Though both the "20 acres per head" systems have far too inadequate carry overs year after year, there is a difference between the two systems favoring the continuous plan.

GENERAL SUMMARY.

Growth Trends

Growth has been defined as of two types, skeletal growth and fattening (3). Unfortunately, the systems of measurements that are considered specific to each of these types of growth and by which the two could be separated (29), were discarded early in the experiment due to the inaccuracy experienced in taking them. Weights constituted the only reliable data collected on the growth of the animals used during the course of the experiments. General observations were recorded and assisted considerably in the interpretation of the results.

In the course of the experiment, as was discussed in the yearly progress reports, all the lots showed fluctuations in weight of very short duration, that is fluctuations from one weighing period to the next. These were attributable to the prevailing weather conditions. Summer weather conditions that resulted in a sudden rejuvenation of the grass were almost invariably followed by more rapid increases in weight in the cattle. Similarly, the losses or occasional gains made by the cattle in the winter season appeared to be closely related to the type of weather and consequent winter feeding conditions which prevailed. The extent of these "short term" fluctuations seems to be governed by two factors, the severity of the changes in the weather, and

the ability of the cows to maintain body weight.

Seasonal Trends

These fluctuations had, however, definite trends that might have been called seasonal trends as they were specific to the seasons. A summer gain was followed by a winter loss and this condition was generally characteristic of all lots.

The summer weights, as will be observed on the charts, accompanying the yearly progress reports, were generally characterized by the most rapid gains during the period prior to the late June weighing. This is undoubtedly the result of the fresh spring pastures and the fact that the cattle, carrying very little or no flesh, were in a good condition to make rapid gains.

A further suggestion regarding the reason for the rapidity of early summer gains or rapid gains in times of succulent forage, lies in the variations found in the chemical composition of the range grasses in their various stages as found on the range. The following table shows the average chemical composition of the five principle range grass species - Stipa comata (spear grass), Agropyron smithii (blue-joint), Bouteloua gracilis (grama grass), Koeleria cristata (June grass), and Poa secunda (Sandberg bluegrass) (33).

It will be observed that in the early stages of growth the grasses are high in protein content and contain sufficient phosphorus and calcium for growth and fattening (25).

Stage of Growth	Protein	Fibre	CHO	Fat	Total Ash	CaO	P_2O_5
	%	%	%	%	%	%	%
Leaf	18.00	24.23	46.17	2.53	9.33	0.561	0.602
Flower	9.61	32.33	48.95	2.41	6.82	0.400	0.414
Seed	7.06	33.54	50.70	2.32	6.46	0.419	0.291
Cured	5.00	33.02	51.76	1.81	8.52	0.530	0.187
After winter exposure	4.18	34.82	50.79	1.26	9.00	0.512	0.178

As the plants mature the protein and phosphorus contents decrease. There is a marked deficiency in phosphorus after the grasses reach the flowering stage. Though phosphorus is needed in very small amounts by the animal it is vital to the proper maintenance of the animal body (34). Lack of a sufficient amount of this element in the cured forage may account in part at least for the retarded gains in the late fall or in late summers, in years when droughts cause the grasses to mature prematurely.

There seems to be no consistency from year to year as to the period in which the most noticeable winter shrinks were suffered by the animals. These seem to have been governed by the severity of the various cold spells or storms and the winter feeding conditions.

Yearly Cycles of Growth

These seasonal trends constitute what might be termed yearly cycles. These cycles were common to all lots and are natural to all range cattle.

The extent of these yearly fluctuations varied from

year to year (Table XIII, Appendix I). This can also be seen on the chart, Plate XIII. Lot 1 and lot 3, the lots grazed at 20 acres per head and 30 acres per head under the rotational system, are not shown in the latter chart as it had been noted these approximate their comparable lots in the continuous system. These year to year differences may be attributed to the yearly variations in growing conditions. Differences will be noted between the lots in the extent of their seasonal trends within their yearly cycles. These are variations from lot to lot in summer gains and winter losses. As has been stated previously, these variations from lot to lot could not be attributed to the prevailing weather of the seasons as this affected all lots equally (Table XIII, Appendix I). The difference in the summer planes of nutrition (the difference in their grazing rates) appeared to be the responsible factor.

The lots on the lower planes had the least ability to make sizable gains and consequently could not suffer as heavy winter losses. The forty acre lot was the most efficient while the thirty acre lots vary somewhat between the forty acre and the two twenty acre lots.

Long term Trends in Growth

The cycles for the various years when combined, form the trends of growth of the various lots during the six year period. These might be called long term trends in growth. The trends of lots 2, 4, and 5, the 40 acres, 30 acres, and

20 acres per head continuously grazed lots, are shown in the chart, Plate XIII. These lots show the general long term trends that were experienced by the lots. The lots in the rotational systems did not vary consistently from their respective lots in the continuous grazing plan as far as long term trends were concerned.

Beginning with the heifers as yearlings, the next 2½ years were spent by all lots in attaining a weight approximating the 1,000 pound level above or below which no serious long term deviations in weight occurred for the remainder of the six year period. This gradual increase could undoubtedly be classified as skeletal growth and range animals could be said to have nearly reached their maturity at about 3½ years. There was, of course, noticeable changes in the body conformation after this time -- that is, a filling out in the abdomen and a general deepening of the body common to all range cows with advancing age. This near development at 42 months is in accordance with standards quoted by Maynard (27) purporting that cattle attain 80 per cent of their mature weight at 43.3 months.

After the first 5 years (4 years of the experiment), a definite spread took place between the growth curves of the lots. The trends of those on the lowest planes of nutrition followed the 1,000 pound level, while the curve of the 40 acres per head lot followed the 1,050 pound level. The trends of the 30 acre lots varied between the two but ap-

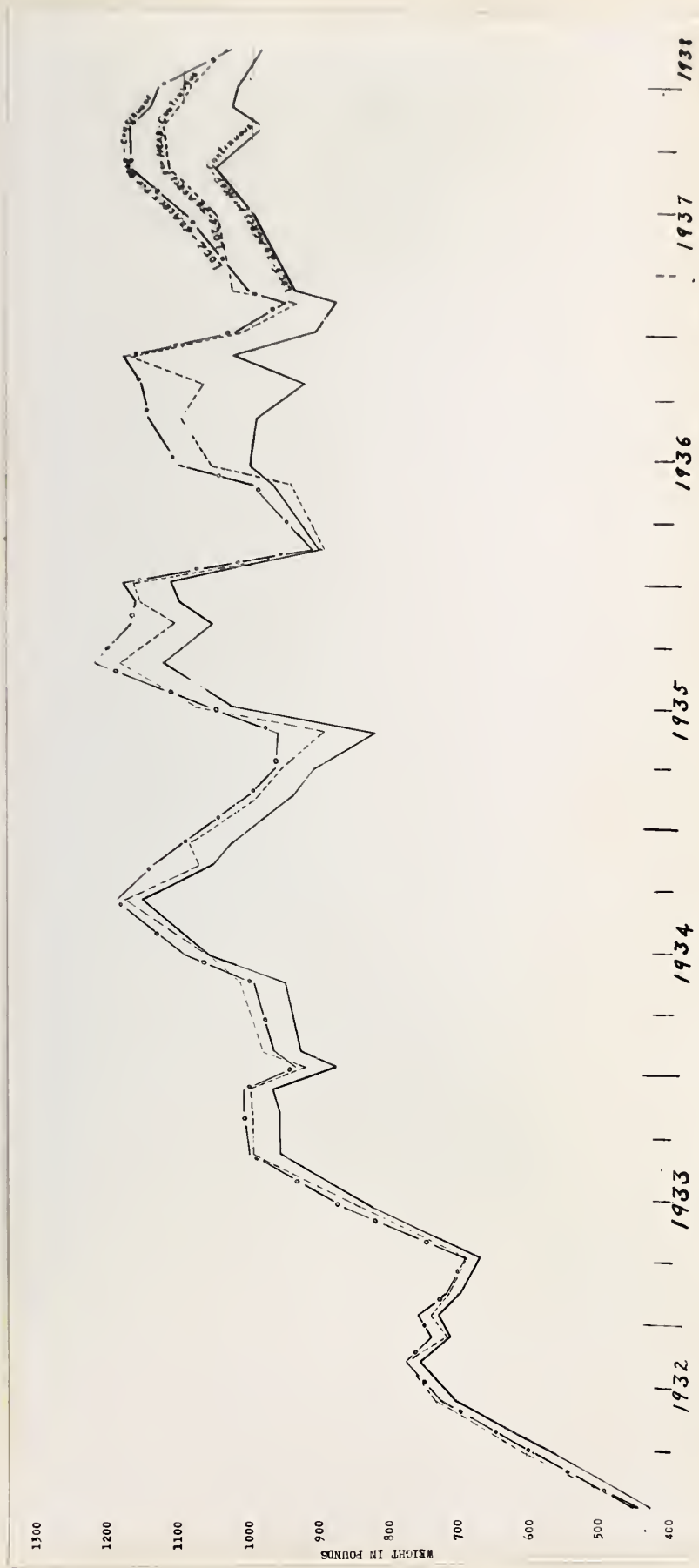

Plate XIII - Showing the trends in growth of Lots 2, 4, and 5 for the six year period.

proximated a level near the 1,050 pound mark also. The summer grazing capacity did seem to have a definite effect on the maturity of the cattle concerned as far as could be determined by their weights.

The significant difference in the growth curves of the lots after the cattle had been on the experiment four years, apart from this gradual spread, was in the marked difference in the extent of their yearly fluctuations in weight. The lots on the lower planes of nutrition seemed to have lost their ability to make substantial summer gains and consequently could not undergo heavy winter losses. The loss of this ability is of great significance.

Significance of Summer Gains and Winter Losses

The extent of this winter loss seems to be dependent on the magnitude of the summer gains. During the winter months range animals in addition to requiring nutrients for the natural body functions in normal maintenance, require large supplies of these essential elements to withstand the periods of extreme variability in temperature, and the increased energy output that may be found necessary to obtain food under winter feeding conditions. If this supply is not forthcoming from the natural forage of the winter pasture or supplemental feeds, the animals are required to draw on the reserves of these nutrients that are stored in the various depots in their bodies. As they draw on these reserves there begins a wasting away of

essential body constituents of fat, carbohydrates, and protein, and of bone in extreme cases. This results in an emaciated condition and in some cases death.

This has been the lot of the groups on the low planes of nutrition. Having been unable to build up sufficient reserves in the summer to meet the demands of the following winter, many would have died if supplementary feeding had not been resorted to.

It is a common practice in ranching to force the breeding herd to winter as much as possible on the natural forage present and to draw on their summer gains to complete the supply of nutrients needed for their winter maintenance. "Winter your cattle in the summer", is a maxim often repeated among ranchers. It is an integral part of their ranch economy. It was shown in this experiment that from the standpoint of costs alone it was better to run the cattle at the higher acreages per head. The proportional estimates of the winter feeding found necessary in the various lots over the period of years indicated that the 20 acre lots required the greater proportions. Actual cost figures were not available every year. The figures for the year 1936-37, though an exceptionally severe winter on the whole, will serve as an example. The feed costsper head for the animals in the various lots were, for lots 1 to 5, $3.89, $2.97, $3.18, $3.15, and $5.60 respectively.

Comparing these figures with one another and correlating them with the extra cost of the pasture at 2.67 cents per acre, the economy of the higher grazing rates becomes very apparent. Of course, winter feeding may not be necessary every winter, depending on the weather conditions and the forage exposed, but there is sufficient spread between the costs of lot 5 and lot 4 to allow lot 5 the added 100 acres pasture if winter feeding was found necessary in only one out of every nine years or between the costs of lots 1 and 3 to allow the former the added acreage if winter feeding was only found necessary in one out of every 2½ years. This does not take into account the effects of the low planes of nutrition on the thrift of the cattle.

Effects of the Grazing Rates on Conformation

The effects of the different intensities and systems of summer grazing on the conformation of the cattle have their only proof in the observations made of the cows during the course of the experiment. Reproductions of photographs of representative cows of the respective lots taken in October, 1936, are shown in Plates VII, VIII, IX, X, and XI. These illustrate the effects of the summer plane of nutrition on the development of the cattle in the various lots. It is to be remembered that while these cattle were grades, they were chosen from a very well bred herd, Hereford bulls having been used exclusively since 1914. At the conclusion of the experiment the cows in lot 2 appeared as

typical well bred range Herefords. They seemed to have developed normally throughout. This was evidenced by their good depth, width, and strong heart girths. In addition they appeared to be in good thrift, possessing a natural covering of flesh and a good hair tone. In contrast, though, the cattle in lots 1 and 5 seemed to have reached normal height, which is in accordance with the findings of Moulton (3). They were decidedly shallower in depth of body, particularly in the chest and flank. They carried little flesh and their skin and hair tone was harsh and dry. In general appearances they were like any common group of off grade cattle, though they were practically of the same breeding as those of lot 2 by virtue of the nature of their selection. The cattle in the "20 acres per head" lots did not differ from one another in their outward signs of thrift or conformation. The same could be said of the two groups grazing at 30 acres per head. However, these latter lots did differ from the "40 acres per head" group and the "20 acres per head" lots. In conformation these individuals did not seem to be noticeably different than those of lot 2, but in fleshing and hair tone they were only slightly superior to the cows in the smaller pastures.

The Relationship of Summer Grazing Rates to Death Loss

Death losses are significant factors in determining ranch income (1). No deaths occurred in the lots on the

higher planes of nutrition. The 4 per cent average annual loss in each of the 20 acres per head lots was directly attributed to their summer plane of nutrition. This 4 per cent annual death loss is 1 per cent higher than that quoted by Potter (32) as the normal death loss on the western ranges of the United States.

Reproduction

Reproduction, in language of the stockman, refers to the calf crop, that is, the number of calves raised to weaning age (1). It, too, has been cited as a very important factor in determining ranch income (32).

The average calf crop for each of the lots 1 to 5 inclusive, for the six year period (4 calf crops) was 70.8 per cent, 87.5 per cent, 84.4 per cent, 78.1 per cent, and 91.6 per cent respectively. These follow the natural progression expected, excepting lot 5, with lot 2 being highest, followed by the 30 acres per head lots and then lot 1. The exceptionally high figure for lot 5, however, thwarts any suggestion that the different rates of grazing had any particular effect on the percentage calf crops of the various lots. The average weaning weights for the various lots during this period, however, do show significant differences. These were 320 pounds, 404 pounds, 353 pounds, 394 pounds, and 360 pounds respectively. That of lot 2 was considerably heavier.

Range Conservation as affected by Grazing Practices

Disregarding the effects on growth and reproduction of the cattle caused by the different carrying capacities, it was found in the experiment that continuous summer grazing plans that allow the pastures to be stocked at the rate of 20 acres per head, definitely would not permit a carry over of forage to be made from year to year such as was needed for the normal preservation of the range. The rate of 40 acres per head allowed a more than adequate carry over to be made in normal years, but the rate of 30 acres per head was slightly inadequate.

Due to the increase in the floral population of Artemisia frigida, while the grasses were apparently being "grubbed" out, there is the suggestion that a predominance of this plant in the forage cover may be an indication of over-grazing on cattle ranges.

Contrary to the reports of many workers in various sections of the western United States, the deferred and rotational system of grazing possessed no decided advantage over the continuous plan from the standpoint of preservation of the range forage. In fact, it had a slight disadvantage in cases of severe overstocking as can be shown by comparing the carry overs of the two 20 acres per head lots.

CONCLUSIONS

From the evidence presented in the manuscript the following conclusions are drawn:

1. The growth trends of groups of range cattle differ one from another according to the rate at which they are grazed during the summer season (the plane of nutrition), being on a lower level for groups pasturing on a limited range.

2. The growth trends of range cattle are characterized by definite yearly cycles of summer gains and winter losses. The magnitude of the summer gains varies significantly from year to year apparently with the season's growing conditions. The magnitude of the winter losses varies with the severity of the weather and the consequent winter feeding conditions.

3. There are significant differences in the ability of groups of cattle grazing at different acreages per head to make substantial summer gains and withstand the effects of the heavy loss of weight during the winter months. These differences, normally expected of range cattle, are above and beyond those mentioned in no. 2 as experienced by all lots and are directly attributable to the summer plane of nutrition.

4. Carrying capacities of 20 acres per head are definitely inadequate to provide the summer gains necessary to prevent winter loss of weight without leading to emaciation. Carrying capacities of 40 acres per head are

sufficient and those of 30 acres per head are borderline.

5. Wintering costs are considerably higher for cattle grazing at low acreages per head in the summer. There is sufficient evidence to substantiate the economy of grazing cattle in this area at 40 acres per head rather than 20 acres per head from this standpoint.

6. The most rapid gains are made by cattle before the grass reaches maturity. The decline in rate of gain is closely related to the decrease in the protein and phosphorus content of the forage as the season advances.

7. Gains made during the first three and one-half years of the life of the range animal constitute skeletal growth mainly.

8. Range cattle on limited summer pasture do not reach the same mature weight as those grazing on ample pasture.

9. Death losses are greatest among cattle grazing on limited summer pasture.

10. There is insufficient evidence to state conclusively that the percentage calf crop is affected by the rate at which cattle are pastured during the summer season.

11. Limited pasturage for range cattle leads to a decrease in the weaning weight of the calves.

12. As far as the growth and reproduction of range cattle is concerned, there is no advantage in practising a rotational system of grazing range lands as compared to a

continuous plan when either rate of 20 or 30 acres per head is used.

13. The forage carry over determinations indicate that an allowance of 40 acres per head is more than adequate to permit proper range conservation, allotments of 30 acres per head are slightly inadequate, while those of 20 acres per head are definitely inadequate.

14. This study does not indicate any advantage in practising rotational as compared with continuous grazing from the standpoint of preservation of the range.

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APPENDIX I

The graphs presented in the manuscript were constructed from the average weights of the different lots taken at various periods during each year. These average weights, together with the individual weights from which they were calculated, appear in the following yearly tables. All weights were calculated to the nearest pound.

The seasonal gains or losses were subjected to statistical analysis. The method used was that presented by Snedecor (23). The F value was determined for each given set of data. The necessary F values to be significant at the 5 per cent and 1 per cent points respectively were found from tables presented by Goulden (22). These are given at the conclusion of each set of data, together with the minimum significant difference that was calculated to be required.

The data was also subjected to statistical analysis under the method outlined by Snedecor (23) to test for differences between the treatments (lots) over the period of six years, to test for yearly differences, and to test for interaction (i.e. were the differences between treatments aggravated by the yearly variations). A summary of this analysis for each season is given in Table XIII.

Individual Weighings of Cattle.

TABLE I

Summer -- 1932

Lot 1 - 20 acres per head - Deferred and Rotational

Cow No.	Apr. 9	June 26	Sept. 12	Nov. 8	Seasonal Gain
12	431	540	690	715	284
13	433	535	638	682	249
14	482	620	736	762	280
15	488	630	744	775	287
16	418	540	662	716	298
19	394	540	660	688	294
Average	441	568	688	723	282

Lot 2 - 40 acres per head - Continuous

Cow. No.	Apr. 9	June 26	Sept. 12	Nov. 8	Seasonal Gain
20	468	610	795	851	383
21	472	630	780	838	366
23	417	550	676	720	303
25	413	560	694	759	346
26	432	570	680	726	294
27	438	560	677	726	288
28	434	615	735	795	361
29	445	575	738	779	334
Average	440	584	722	774	334

Lot 3 - 30 acres per head - Deferred and Rotational

Cow No.	Apr. 9	June 26	Sept. 12	Nov. 8	Seasonal Gain
31	460	590	707	742	282
32	415	555	663	689	274
33	414	545	645	687	273
34	453	600	735	764	311
35	482	630	795	836	354
36	405	535	648	693	288
37	439	550	692	737	298
39	448	590	733	771	323
Average	440	574	702	740	300

TABLE I (Continued)

Lot 4 - 30 acres per head - Continuous

Cow No.	Apr. 9	June 26	Sept. 12	Nov. 8	Seasonal Gain
42	443	580	727	777	334
43	434	610	725	763	329
44	459	590	732	788	329
45	477	635	800	833	356
46	452	570	678	736	284
47	389	585	660	710	321
48	483	630	790	842	359
49	412	570	715	740	328
Average	444	596	728	773	330

Lot 5 - 20 acres per head - Continuous

Cow No.	Apr. 9	June 26	Sept. 12	Nov. 8	Seasonal Gain
50	430	570	678	720	290
53	431	550	706	760	329
56	398	515	677	726	328
57	431	560	693	773	342
58	414	565	712	748	334
59	427	580	740	784	357
Average	422	557	701	752	330

F value for lots 1, 2, 3, 4, and 5 = 7.75

F value to be significant at 5% point = 2.68

F value to be significant at 1% point = 4.03

Minimum significant difference required = 31 lb.

TABLE II

Summer -- 1933

Lot I - 20 acres per head - Deferred and Rotational

Cow No.	Mar. 28	June 20	Sept. 8	Nov. 10	Seasonal Gain
12	657	785	940	967	310
13	632	785	900	935	303
14	673	845	990	983	310
15	712	825	1030	1035	323
16	688	835	980	985	297
19	605	745	880	877	272
Average	661	803	953	964	303

Lot 2 - 40 acres per head - Continuous

Cow No.	Mar. 28	June 20	Sept. 8	Nov. 10	Seasonal Gain
20	765	920	1100	1112	347
21	727	925	1050	1072	345
23	615	810	905	915	300
25	678	850	975	960	282
26	648	830	930	935	287
27	673	840	930	950	277
28	712	925	1070	1075	363
29	695	890	1030	1025	330
Average	689	861	999	1006	316

Lot 3 - 30 acres per head - Deferred and Rotational

Cow No.	Mar. 28	June 20	Sept. 8	Nov. 10	Seasonal Gain
31	677	860	1010	983	306
32	572	740	870	867	295
33	612	720	880	858	246
34	682	830	970	982	300
35	728	910	1035	1025	297
36	617	765	900	908	291
37	655	835	960	990	335
39	662	860	1020	1035	373
Average	651	815	956	956	305

TABLE II (Continued)

Lot 4 - 30 acres per head - Continuous

Cow No.	Mar. 28	June 20	Sept. 8	Nov. 10	Seasonal Gain
42	717	845	1000	1007	290
43	643	800	965	963	320
44	703	840	995	983	280
45	737	925	1075	1072	335
46	643	785	920	915	272
47	653	775	910	923	270
48	730	895	1090	1100	370
49	673	820	970	983	310
Average	687	836	991	993	306

Lot 5 - 20 acres per head - Continuous

Cow No.	Mar. 28	June 20	Sept. 8	Nov. 10	Seasonal Gain
50	673	840	940	945	272
53	665	795	925	925	260
56	615	750	915	907	292
57	692	830	985	987	295
58	660	800	940	948	288
59	710	860	1020	1017	307
Average	669	612	954	955	286

F value for lots 1, 2, 3, 4, and 5 = .89

F value to be significant at 5% point = 2.68

F value to be significant at 1% point = 4.03

Minimum significant difference required = 35 lb.

TABLE III

Summer -- 1934

Lot 1 - 20 acres per head - Deferred and Rotational

Cow No.	Feb. 6	May 17	June 27	Sept. 6	Nov. 6	Seasonal Gain
12	965	1040	970	1050	978	13
13	945	890	885	1005	917	-28
14	935	1040	1120	1240	1185	250
15	1020	1090	1205	1330	1282	262
16	1040	1000	1065	1220	1177	137
19	860	865	940	1110	1062	202
Average	961	988	1031	1156	1100	139

Lot 2 - 40 acres per head - Continuous

Cow No.	Feb. 6	May 17	June 27	Sept. 6	Nov. 6	Seasonal Gain
20	1060	1080	1165	1370	1190	130
21	1025	980	1125	1190	1162	137
23	845	940	1035	1130	1113	268
25	945	995	1125	1240	1228	283
26	915	910	960	1030	993	78
27	890	965	1100	1210	1197	307
28	1020	1135	1170	1215	1147	127
29	1000	920	1045	1140	1080	80
Average	963	991	1091	1191	1139	176

Lot 3 - 30 acres per head - Deferred and Rotational

Cow No.	Feb. 6	May 17	June 27	Sept. 6	Nov. 6	Seasonal Gain
31	945	1050	1140	1265	1273	328
32	830	965	1025	1150	1147	317
33	840	815	875	930	915	75
34	960	1095	1160	1310	1305	345
35	1040	1030	1090	1150	1062	22
36	910	905	1000	1120	1087	177
37	945	950	1035	1110	1077	132
39	1030	1020	1110	1145	1110	80
Average	938	979	1054	1148	1122	184

TABLE III (Continued)

Lot 4 - 30 acres per head - Continuous

Cow No.	Feb. 6	May 17	June 27	Sept. 6	Nov. 6	Seasonal Gain
42	970	945	960	1080	1015	45
43	970	930	980	1105	993	23
44	980	1115	1070	1210	1103	123
45	1035	1050	1105	1290	1063	28
46	890	980	1075	1210	1170	280
47	905	1015	1095	1220	1198	293
48	1095	1110	1155	1190	1027	-68
49	980	950	1020	1110	1005	25
Average	978	1012	1058	1178	1072	94

Lot 5 - 20 acres per head - Continuous

Cow No.	Feb. 6	May 17	June 27	Sept. 6	Nov. 6	Seasonal Gain
50	895	1050	1100	1250	1190	295
53	905	855	975	1100	960	55
56	885	990	1015	1110	1030	145
57	960	950	1115	1210	1073	113
58	935	910	1010	1100	1032	98
59	965	930	1130	1150	1030	65
Average	924	948	1058	1153	1052	128

F value for lots 1, 2, 3, 4, and 5 = .87

F value to be significant at 5% point = 2.68

F value to be significant at 1% point = 4.03

Minimum significant difference required = 132 lb.

TABLE IV

Summer -- 1935

Lot I - 20 acres per head - Deferred and Rotational

Cow No.	Mar. 12	May 22	June 24	Sept. 5	Nov. 2	Seasonal Gain
12	850	920	930	1025	1015	165
13	885	765	840	980	945	60
14	1070	905	1040	1185	1190	120
15	1160	1075	1175	1305	1313	153
16	1070	870	985	1105	1052	-18
19	950	800	930	1035	1025	75
Average	999	889	983	1106	1090	92

Lot 2 - 40 acres per head - Continuous

Cow No.	Mar. 12	May 22	June 24	Sept. 5	Nov. 2	Seasonal Gain
20	1020	925	1060	1275	1220	200
21	945	905	1075	1270	1243	297
23	940	1025	1015	1130	1062	122
25	1025	1015	1150	1285	1255	230
26	870	860	945	1100	1052	182
27	1035	980	1110	1250	1213	178
28	975	1060	1100	1270	1207	232
29	900	910	1020	1205	1130	230
Average	964	960	1059	1223	1173	209

Lot 3 - 30 acres per head - Deferred and Rotational

Cow No.	Mar. 12	May 22	June 24	Sept. 5	Nov. 2	Seasonal Gain
31	1105	1030	1170	1340	1325	220
32	970	895	1035	1135	1142	172
33	810	765	905	1020	982	172
34	1170	1080	1220	1250	1145	-25
35	890	855	1030	1130	1053	163
36	935	890	1025	1140	1157	222
37	950	1045	1240	1235	1233	283
39	965	925	1055	1105	1063	98
Average	974	936	1085	1169	1138	163

TABLE IV (Continued)

Lot 4 - 30 acres per head - Continuous

Cow No.	Mar. 12	May 22	June 24	Sept. 5	Nov. 2	Seasonal Gain
42	935	810	1025	1135	1058	123
43	860	820	1015	1155	1055	195
44	940	1060	1165	1265	1178	238
45	955	845	1025	1195	1060	105
46	1040	925	1105	1225	1168	128
47	1040	965	1165	1270	1255	215
48	930	865	1065	1120	1060	130
49	910	850	1040	1130	1045	135
Average	951	893	1076	1187	1110	159

Lot 5 - 20 acres per head - Continuous

Cow No.	Mar. 12	May 22	June 24	Sept. 5	Nov. 2	Seasonal Gain
50	1030	895	1110	1185	1092	62
53	810	750	950	1085	995	185
56	890	780	980	1075	1032	142
57	940	830	1055	1175	1073	133
58	895	810	995	1075	1000	105
59	885	855	1070	1170	1145	260
Average	908	820	1027	1128	1056	148

F value for lots 1, 2, 3, 4, and 5 = 2.54

F value to be significant at 5% point = 2.68

F value to be significant at 1% point = 4.03

Minimum significant difference required = 79 lb.

TABLE V

Summer -- 1936

Lot 1 - 20 acres per head - Deferred and Rotational

Cow No.	Feb. 22	May 26	June 25	Sept. 3	Oct. 23	Seasonal Gain
12	830	865	935	930	958	128
13	835	840	865	850	877	42
14	1000	1065	980	1020	1055	55
15	1050	1075	1105	1130	1135	85
16	945	850	930	905	905	-40
19	825	810	910	970	1030	205
Average	914	918	954	968	993	79

Lot 2 - 40 acres per head - Continuous

Cow No.	Feb. 22	May 26	June 25	Sept. 3	Oct. 23	Seasonal Gain
20	925	1060	1180	1270	1295	370
21	980	1010	1140	1205	1260	280
23	860	830	950	990	1010	150
25	965	995	1130	1160	1195	230
26	865	1000	1020	1100	1075	210
27	910	920	1030	1085	1090	180
28	920	1150	1310	1250	1282	362
29	865	1015	1070	1120	1058	193
Average	911	998	1104	1148	1158	247

Lot 3 - 30 acres per head - Deferred and Rotational

Cow No.	Feb. 22	May 26	June 25	Sept. 3	Oct. 23	Seasonal Gain
31	1060	1090	1150	1315	1345	285
32	900	910	1030	1090	1085	185
33	820	850	930	1045	1055	235
34	1000	1005	1070	1140	1075	75
35	875	945	1000	1100	1040	165
36	935	860	1010	1150	1150	215
37	980	1160	1095	1210	1180	200
39	910	950	1000	1120	1128	218
Average	935	971	1036	1146	1132	197

TABLE V (Continued)

Lot 4 - 30 acres per head - Continuous

Cow No.	Feb. 22	May 26	June 25	Sept. 3	Oct. 23	Seasonal Gain
42	850	895	990	1020	985	135
43	840	925	1035	1030	998	158
44	930	995	1115	1125	1075	145
45	880	980	1110	1190	1188	308
46	900	930	1035	1075	1020	120
47	985	1035	1150	1215	1140	155
48	910	905	1005	1100	1140	230
49	850	875	1020	1050	1020	170
Average	893	943	1058	1101	1070	177

Lot 5 - 20 acres per head - Continuous

Cow No.	Feb. 22	May 26	June 25	Sept. 3	Oct. 23	Seasonal Gain
50	1000	1130	1030	1000	898	-102
53	850	875	970	920	913	63
56	860	1000	990	1000	910	50
57	915	1005	1085	1045	965	50
58	865	865	930	930	880	15
59	925	940	1030	1050	980	55
Average	902	969	1001	991	924	22

F value for lots 1, 2, 3, 4, and 5 = 11.34

F value to be significant at 5% point = 2.68

F value to be significant at 1% point = 4.03

Minimum significant difference required = 82 lb.

TABLE VI

Summer -- 1937

Lot 1 - 20 acres per head - Deferred and Rotational

Cow No.	Mar. 6	June 26	Sept. 4	Nov. 3	Seasonal Gain
12	930	830	870	922	-8
13	895	830	895	977	82
14	1055	935	1000	1025	-30
15	1065	960	1010	1093	28
16	960	925	1010	1057	97
19	995	815	855	950	-45
Average	983	883	942	1004	21

Lot 2 - 40 acres per head - Continuous

Cow No.	Mar. 6	June 26	Sept. 4	Nov. 3	Seasonal Gain
20	1035	1160	1265	1283	248
21	1100	1135	1240	1252	152
23	925	945	1020	990	65
25	1010	1140	1195	1200	190
26	965	1055	1110	1105	140
27	915	1085	1215	1242	327
28	1125	1180	1235	1257	132
29	965	1030	1110	1087	122
Average	1005	1091	1174	1177	172

Lot 3 - 30 acres per head - Deferred and Rotational

Cow No.	Mar. 6	June 26	Sept. 4	Nov. 3	Seasonal Gain
31	1150	1200	1225	1267	117
32	930	955	985	1015	85
33	945	940	985	982	37
34	1065	1020	1020	997	-68
35	950	1070	1135	1190	240
36	1010	990	1010	1060	50
37	1087	1100	1090	1140	53
39	1000	1115	1055	1070	70
Average	1017	1049	1063	1090	73

TABLE VI (Continued)

Lot 4 - 30 acres per head - Continuous

Cow No.	Mar. 6	June 26	Sept. 4	Nov. 3	Seasonal Gain
42	990	1065	1240	1175	185
43	990	935	1040	1050	60
44	1045	1020	1110	1170	125
45	1110	1045	1140	1177	67
46	955	1035	1100	1092	137
47	1065	1070	1055	1148	83
48	1085	1080	1150	1085	0
49	970	1150	1120	1130	160
Average	1026	1050	1119	1128	102

Lot 5 - 20 acres per head - Continuous

Cow No.	Mar. 6	June 26	Sept. 4	Nov. 3	Seasonal Gain
50	985	980	1065	1000	15
53	885	960	1020	875	-10
56	900	980	1050	1005	105
57	1000	1085	1105	1013	13
58	905	965	1000	970	65
59	950	1010	1075	1038	88
Average	938	997	1053	984	46

F value for lots 1, 2, 3, 4, and 5 = 4.92

F value to be significant at 5% point = 2.68

F value to be significant at 1% point = 4.03

Minimum significant difference required = 81 lb.

TABLE VII

Winter - 1932-33

Lot 1 - 20 acres per head - Deferred and Rotational

Cow No.	Nov. 8	Dec. 13	Jan. 14	Feb. 14	Mar. 28	Seasonal Gain
12	715	680	685	690	657	-58
13	682	633	655	630	632	-50
14	762	715	700	700	673	-89
15	775	730	760	705	712	-63
16	716	655	705	690	688	-28
19	688	650	650	620	605	-83
Average	723	677	692	672	661	-62

Lot 2 - 40 acres per head - Continuous

Cow No.	Nov. 8	Dec. 13	Jan. 14	Feb. 14	Mar. 28	Seasonal Gain
20	851	805	840	790	765	-86
21	838	792	800	755	727	-111
23	720	677	680	645	615	-105
25	759	697	735	680	678	-81
26	726	675	690	670	648	-78
27	726	727	730	710	673	-53
28	795	790	810	760	712	-83
29	779	748	760	720	695	-84
Average	774	739	756	716	689	-85

Lot 3 - 30 acres per head - Deferred and Rotational

Cow No.	Nov. 8	Dec. 13	Jan. 14	Feb. 14	Mar. 28	Seasonal Gain
31	742	697	725	680	677	-65
32	689	620	630	605	572	-117
33	687	653	650	660	612	-75
34	764	730	725	705	682	-82
35	836	745	785	745	728	-108
36	693	640	680	630	617	-76
37	737	695	715	685	655	-82
39	771	702	730	690	662	-109
Average	740	685	705	675	651	-89

TABLE VII (Continued)

Lot 4 - 30 acres per head - Continuous

Cow No.	Nov. 8	Dec. 13	Jan. 14	Feb. 14	Mar. 28	Seasonal Gain
42	777	715	780	735	717	-60
43	763	675	710	685	643	-120
44	788	703	750	725	703	-85
45	833	785	790	765	737	-96
46	736	688	695	670	643	-93
47	710	683	700	675	653	-57
48	842	768	750	770	730	-112
49	740	683	730	665	673	-67
Average	773	712	738	711	687	-90

Lot 5 - 20 acres per head - Continuous

Cow No.	Nov. 8	Dec. 13	Jan. 14	Feb. 14	Mar. 28	Seasonal Gain
50	720	682	720	690	673	-47
53	760	713	730	685	665	-95
56	726	683	675	665	615	-111
57	773	727	740	705	692	-81
58	748	715	730	700	660	-88
59	784	743	765	730	710	-74
Average	752	710	727	696	669	-83

F value for lots 1, 2, 3, 4, and 5 = 1.78

F value to be significant at 5% point = 2.68

F value to be significant at 1% point = 4.03

Minimum significant difference required = 25 lb.

TABLE VIII

Winter - 1933-34

Lot 1 - 20 acres per head - Deferred and Rotational

Cow No.	Nov. 10	Dec. 11	Jan. 13	Feb. 6	Seasonal Gain
12	967	1000	895	965	-2
13	935	940	895	945	10
14	983	995	890	935	-48
15	1035	1050	960	1020	-15
16	985	1000	930	1040	55
19	877	895	825	860	-17
Average	964	980	896	961	-3

Lot 2 - 40 acres per head - Continuous

Cow No.	Nov. 10	Dec. 11	Jan. 13	Feb. 6	Seasonal Gain
20	1112	1115	1020	1060	-52
21	1072	1080	990	1025	-47
23	915	915	840	845	-70
25	960	960	860	945	-15
26	935	925	905	915	-20
27	950	945	875	890	-60
28	1075	1095	1025	1020	-55
29	1025	1020	940	1000	-25
Average	1006	1007	932	963	-43

Lot 3 - 30 acres per head - Deferred and Rotational

Cow No.	Nov. 10	Dec. 11	Jan. 13	Feb. 6	Seasonal Gain
31	983	980	890	945	-38
32	867	875	775	830	-37
33	858	890	840	840	-18
34	982	995	895	960	-22
35	1025	1035	950	1040	15
36	908	920	855	910	2
37	990	995	935	945	-45
39	1035	1020	960	1030	-5
Average	956	964	888	938	-18

TABLE VIII (Continued)

Lot 4 - 30 acres per head - Continuous

Cow No.	Nov. 10	Dec. 11	Jan. 13	Feb. 6	Seasonal Gain
42	1007	1015	920	970	-37
43	963	965	900	970	7
44	983	990	910	980	-3
45	1072	1090	1015	1035	-37
46	915	910	820	890	-25
47	923	925	845	905	-18
48	1100	1100	1045	1095	-5
49	983	990	885	980	-3
Average	993	998	918	978	-15

Lot 5 - 20 acres per head - Continuous

Cow No.	Nov. 10	Dec. 11	Jan. 13	Feb. 6	Seasonal Gain
50	945	950	845	895	-50
53	925	945	825	905	-20
56	907	920	830	885	-22
57	987	1010	930	960	-27
58	948	940	875	935	-13
59	1017	1015	940	965	-52
Average	955	963	874	924	-31

F value for lots 1, 2, 3, 4, and 5 = 3.33

F value to be significant at 5% point = 2.68

F value to be significant at 1% point = 4.03

Minimum significant difference required = 26 lb.

TABLE IX

Winter - 1934-35

Lot 1 - 20 acres per head - Deferred and Rotational

Cow No.	Nov. 6	Dec. 8	Jan. 31	Mar. 12	Seasonal Gain
12	978	980	855	860	-118
13	917	955	825	885	-32
14	1185	1175	1105	1070	-115
15	1282	1310	1210	1160	-122
16	1177	1180	1130	1070	-107
19	1062	1070	1000	950	-112
Average	1100	1112	1021	999	-101

Lot 2 - 40 acres per head - Continuous

Cow No.	Nov. 6	Dec. 8	Jan. 31	Mar. 12	Seasonal Gain
20	1190	1165	1060	1020	-170
21	1162	1095	1000	945	-217
23	1113	1085	975	940	-173
25	1228	1185	1085	1025	-203
26	993	940	875	870	-123
27	1197	1175	1075	1035	-162
28	1147	1105	995	975	-172
29	1080	1035	950	900	-180
Average	1139	1098	1002	964	-175

Lot 3 - 30 acres per head - Deferred and Rotational

Cow No.	Nov. 6	Dec. 8	Jan. 31	Mar. 12	Seasonal Gain
31	1273	1255	1110	1105	-168
32	1147	1135	1000	970	-177
33	915	900	830	810	-105
34	1305	1320	1215	1170	-135
35	1062	1010	930	890	-172
36	1087	1050	955	935	-152
37	1077	1070	945	950	-127
39	1110	945	955	965	-145
Average	1122	1086	992	974	-148

TABLE IX (Continued)

Lot 4 - 30 acres per head - Continuous

Cow No.	Nov. 6	Dec. 8	Jan. 31	Mar. 12	Seasonal Gain
42	1015	1075	995	935	-80
43	993	995	890	860	-133
44	1103	1085	975	940	-163
45	1063	1050	960	955	-108
46	1170	1190	1075	1040	-130
47	1198	1215	1100	1040	-158
48	1027	1055	1000	930	-97
49	1005	1015	930	910	-95
Average	1072	1085	991	951	-120

Lot 5 - 20 acres per head - Continuous

Cow No.	Nov. 6	Dec. 8	Jan. 31	Mar. 12	Seasonal Gain
50	1190	1175	1085	1030	-160
53	960	930	840	810	-150
56	1030	1015	900	890	-140
57	1073	1050	960	940	-133
58	1032	985	920	895	-137
59	1030	1000	930	885	-145
Average	1052	1026	939	908	-144

F value for lots 1, 2, 3, 4, and 5 = 7.74

F value to be significant at 5% point = 2.68

F value to be significant at 1% point = 4.03

Minimum significant difference required = 31 lb.

TABLE X

Winter - 1935-36

Lot 1 - 20 acres per head - Deferred and Rotational

Cow No.	Nov. 2	Dec. 6	Jan. 4	Feb. 22	Seasonal Gain
12	1015	1065	1060	830	-185
13	945	1045	1050	835	-110
14	1190	1225	1230	1000	-190
15	1313	1325	1330	1050	-263
16	1052	1120	1130	945	-107
19	1025	1045	1040	825	-200
Average	1090	1138	1140	914	-176

Lot 2 - 40 acres per head - Continuous

Cow No.	Nov. 2	Dec. 6	Jan. 4	Feb. 22	Seasonal Gain
20	1220	1260	1280	925	-295
21	1243	1255	1240	980	-263
23	1062	1035	1090	860	-202
25	1255	1235	1230	965	-290
26	1052	1055	1080	865	-187
27	1213	1135	1190	910	-303
28	1207	1190	1200	920	-287
29	1130	1160	1160	865	-265
Average	1173	1166	1184	911	-262

Lot 3 - 30 acres per head - Deferred and Rotational

Cow No.	Nov. 2	Dec. 6	Jan. 4	Feb. 22	Seasonal Gain
31	1325	1365	1330	1060	-265
32	1142	1150	1120	900	-242
33	982	1025	1040	820	-162
34	1145	1230	1260	1000	-145
35	1053	1130	1110	875	-178
36	1157	1180	1160	935	-222
37	1233	1225	1190	980	-253
39	1063	1090	1120	910	-153
Average	1138	1178	1166	935	-202

TABLE X (Continued)

Lot 4 - 30 acres per head - Continuous

Cow No.	Nov. 2	Dec. 6	Jan. 4	Feb. 22	Seasonal Gain
42	1058	1120	1130	850	-208
43	1055	1130	1110	840	-215
44	1178	1210	1230	930	-248
45	1060	1130	1160	880	-180
46	1168	1150	1170	900	-268
47	1255	1250	1290	985	-270
48	1060	1135	1130	910	-150
49	1045	1155	1140	850	-195
Average	1110	1160	1170	893	-217

Lot 5 - 20 acres per head - Continuous

Cow No.	Nov. 2	Dec. 6	Jan. 4	Feb. 22	Seasonal Gain
50	1092	1115	1150	1000	-92
53	995	1035	1060	850	-145
56	1032	1065	1070	860	-172
57	1073	1160	1170	915	-158
58	1000	1065	1060	865	-135
59	1145	1170	1190	925	-224
Average	1056	1102	1116	902	-154

F value for lots 1, 2, 3, 4, and 5 = 5.24

F value to be significant at 5% point = 2.68

F value to be significant at 1% point = 4.03

Minimum significant difference required = 55 lb.

TABLE XI

Winter - 1936-37

Lot 1 - 20 acres per head - Deferred and Rotational

Cow No.	Oct. 23	Dec. 2	Jan. 8	Feb. 9	Mar. 6	Seasonal Gain
12	958	1070	955	825	930	-28
13	877	985	875	875	895	18
14	1055	1110	1055	935	1055	0
15	1135	1255	1105	975	1065	-70
16	905	1035	875	905	960	55
19	1030	1160	1040	885	995	-35
Average	993	1103	984	900	983	-10

Lot 2 - 40 acres per head - Continuous

Cow No.	Oct. 23	Dec. 2	Jan. 8	Feb. 9	Mar. 6	Seasonal Gain
20	1295	1340	1120	1015	1035	-260
21	1260	1245	1090	1060	1100	-160
23	1010	1045	940	875	925	-85
25	1195	1215	1075	950	1010	-185
26	1075	1115	975	875	965	-85
27	1090	1130	945	895	915	-175
28	1282	1290	1160	1060	1125	-157
29	1058	1080	905	895	965	-93
Average	1158	1183	1026	953	1005	-153

Lot 3 - 30 acres per head - Deferred and Rotational

Cow No.	Oct. 23	Dec. 2	Jan. 8	Feb. 9	Mar. 6	Seasonal Gain
31	1345	1355	1245	1115	1150	-185
32	1085	1105	965	845	930	-155
33	1055	1050	945	865	945	-110
34	1075	1215	1050	960	1065	-10
35	1040	1065	925	855	950	-90
36	1150	1215	1075	930	1010	-140
37	1180	1245	1055	1030	1087	-93
39	1128	1155	995	940	1000	-128
Average	1132	1176	1032	943	1017	-114

TABLE XI (Continued)

Lot 4 - 30 acres per head - Continuous

Cow No.	Oct. 23	Dec. 2	Jan. 8	Feb. 9	Mar. 6	Seasonal Gain
42	985	1095	945	880	990	5
43	998	1115	955	920	990	-8
44	1075	1200	980	965	1045	-30
45	1188	1330	1130	1010	1110	-78
46	1020	1090	975	880	955	-65
47	1140	1230	1065	965	1065	-75
48	1140	1225	1090	990	1085	-55
49	1020	1100	965	865	970	-50
Average	1070	1173	1013	934	1026	-44

Lot 5 - 20 acres per head - Continuous

Cow No.	Oct. 23	Dec. 2	Jan. 8	Feb. 9	Mar. 6	Seasonal Gain
50	898	1040	935	905	985	87
53	913	1015	885	860	885	-28
56	910	1010	875	810	900	-10
57	965	1015	910	920	1000	35
58	880	1005	890	800	905	25
59	980	1070	940	915	950	-30
Average	924	1026	906	878	938	13

F value for lots 1, 2, 3, 4, and 5 = 4.00

F value to be significant at 5% point = 2.68

F value to be significant at 1% point = 4.03

Minimum significant difference required = 108 lb.

TABLE XII

Winter - 1937-38

Lot 1 - 20 acres per head - Deferred and Rotational

Cow No.	Nov. 3	Dec. 3	Jan. 4	Mar. 2	Seasonal Gain
12	922	1000	1015	890	-32
13	977	1060	1065	1015	38
14	1025	1125	1130	1045	20
15	1093	1205	1125	1140	47
16	1057	1170	1140	1055	-2
19	950	1000	975	910	-40
Average	1004	1093	1075	1009	5

Lot 2 - 40 acres per head - Continuous

Cow No.	Nov. 3	Dec. 3	Jan. 4	Mar. 2	Seasonal Gain
20	1283	1245	1260	1125	-158
21	1252	1180	1150	1065	-187
23	990	1000	980	915	-75
25	1200	1140	1165	995	-205
26	1105	1100	1030	940	-165
27	1242	1235	1230	1135	-107
28	1257	1230	1245	1110	-147
29	1087	1060	1139	970	-117
Average	1177	1149	1139	1032	-145

Lot 3 - 30 acres per head - Deferred and Rotational

Cow No.	Nov. 3	Dec. 3	Jan. 4	Mar. 2	Seasonal Gain
31	1267	1300	1245	1170	-97
32	1015	1075	1105	880	-135
33	982	1000	1000	925	-57
34	997	1055	935	1065	68
35	1190	1240	1170	1020	-170
36	1060	1080	1015	1025	-35
37	1140	1145	1175	1110	-30
39	1070	1105	1110	1025	-45
Average	1090	1125	1094	1028	-63

TABLE XII (Continued)

Lot 4 - 30 acres per head - Continuous

Cow No.	Nov. 3	Dec. 3	Jan. 4	Mar. 2	Seasonal Gain
42	1175	1170	1130	1065	-110
43	1050	1005	1020	970	-80
44	1170	1135	1110	1060	-110
45	1177	1150	1095	1040	-137
46	1092	1090	1050	1020	-72
47	1148	1095	1120	1020	-128
48	1085	1090	1080	1080	-5
49	1130	1095	1105	1055	-75
Average	1128	1104	1089	1039	-89

Lot 5 - 20 acres per head - Continuous

Cow No.	Nov. 3	Dec. 3	Jan. 4	Mar. 2	Seasonal Gain
50	1000	1040	1045	1000	0
53	875	945	960	950	75
56	1005	1040	1035	945	-60
57	1013	1035	1010	1030	17
58	970	1015	1010	1025	55
59	1038	1090	1065	975	-63
Average	984	1028	1021	988	4

F value for lots 1, 2, 3, 4, and 5 = 10.36

F value to be significant at 5% point = 2.68

F value to be significant at 1% point = 4.03

Minimum significant difference required = 61 lb.

TABLE XIII

Analysis of Variance

A. Winters 1932-33 to 1937-38 inclusive

	Degrees of Freedom	Mean Square	Calculated F value	F value at:- 5% point	1% point
Treatments	4	73,968.95	28.94	2.42	3.41
Years	5	172,989.86	67.68	2.26	3.10
Treatments X years (Interaction)	20	1,840.46	.72	1.80	2.28
Error	186	2,555.78			
Total	215				

Minimum significant difference required = 23 lb.

B. Summers 1932 to 1937 inclusive

	Degrees of Freedom	Mean Square	Calculated F value	F value at:- 5% point	1% point
Treatments	4	54,545.4	8.42	2.42	3.41
Years	5	312,183.46	48.18	2.26	3.10
Treatments X years (Interaction)	20	10,677.31	1.65	1.80	2.28
Error	186	6,479.32			
Total	215				

Minimum significant difference required = 38 lb.

APPENDIX II

Summary of Calf Crops.

TABLE I

1934

Lot No.	No. Cows in Lot	*% Calves Born	**% Calves Weaned	Average Weaning Weight
1	6	50.0	33.3	312.5 lb.
2	8	62.5	62.5	411.2 "
3	8	62.5	62.5	341.8 "
4	8	75.0	50.0	404.5 "
5	6	83.3	83.3	351.0 "

TABLE II

1935

Lot No.	No. Cows in Lot	*% Calves Born	**% Calves Weaned	Average Weaning Weight
1	6	100.0	100.0	368.8 lb.
2	8	100.0	100.0	420.1 "
3	8	100.0	100.0	364.2 "
4	8	100.0	100.0	425.2 "
5	6	100.0	100.0	388.3 "

TABLE III

1936

Lot No.	No. Cows in Lot	*% Calves Born	**% Calves Weaned	Average Weaning Weight
1	6	83.3	83.3	294.4 lb.
2	8	100.0	100.0	365.4 "
3	8	100.0	87.5	347.4 "
4	8	100.0	75.0	359.0 "
5	6	100.0	83.3	337.7 "

* Calves born dead and alive
** Calves weaned, based on the number of cows in the lot.

TABLE IV

1937

Lot No.	No. Cows in Lot	*% Calves Born	**% Calves Weaned	Average Weaning Weight
1	6	66.7	66.7	305.0 lb.
2	8	87.5	87.5	418.0 "
3	8	87.5	87.5	358.0 "
4	8	87.5	87.5	389.0 "
5	6	100.0	100.0	362.0 "

* Calves born dead and alive.
** Calves weaned, based on the number of cows in the lot.

APPENDIX III

TABLE I

Instructions for weighing cattle

1. Cattle must be weighed at the same time of the day according to the season.

April	10 a.m. to 11 a.m.
May	9 a.m. to 10 a.m.
June	7 a.m. to 9 a.m.
July	7 a.m. to 9 a.m.
August	8 a.m. to 9 a.m.
September	9 a.m. to 10 a.m.
October	9 a.m. to 10 a.m.
November	10 a.m. to 11 a.m.

The above times of weighing must be carried out as nearly as possible. Winter weighings are done according to weather conditions.

2. Before weighing cattle they should be allowed to stand in the corral one hour before weighing.

3. Cattle should be weighed as speedily as possible.

4. In individual weighing, if there is any doubt as to a number, no delay should be made in identifying it, but it should be placed in the side corral and left till later for identification.

5. Cattle are weighed off the grass without water, and all possible precautions should be taken in preventing cattle from drinking.

TABLE I (Continued)

6. All capacity heifers should be trailed in, in separate lots and left in the corrals for one hour before weighing.

TABLE II

Order of grazing on grazing capacity fields

System	Year	Order*	System	Year	Order*
20 Acres per head, Deferred and Rotational	1931	1-3-6	30 Acres per head, Deferred and Rotational	1931	9-4-7
	1932	3-1-6		1932	4-9-7
	1933	6-3-1		1933	7-4-9
	1934	3-6-1		1934	4-7-9
	1935	1-6-3		1935	9-7-4
	1936	6-1-3		1936	7-9-4
	1937	1-3-6		1937	4-9-7

* "Order" refers to the sequence of grazing followed each year. e.g. In 1931 under the 20 acres per head deferred and rotational system, field 1 would be grazed for the first third of the summer grazing season, field 3 for the second third, and field 6 for the third or last portion.

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